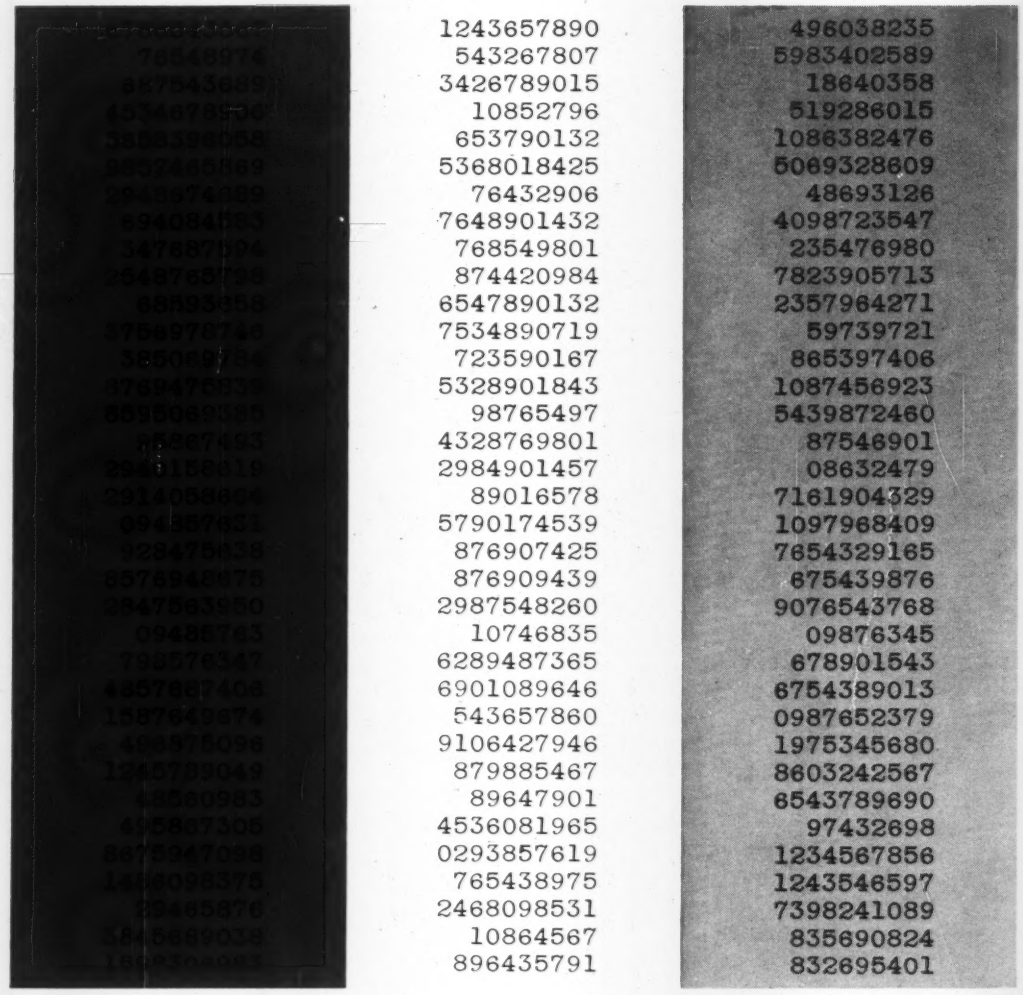
INSTRUMENTS AND CONTROL SYSTEMS

INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER



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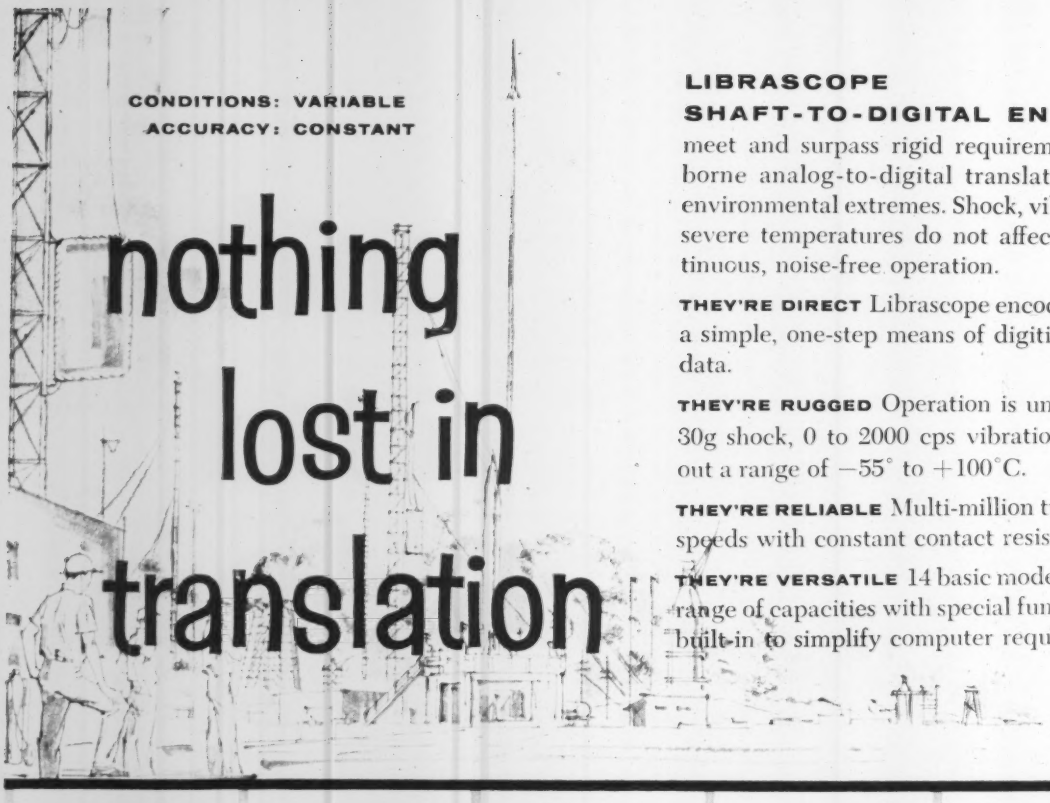

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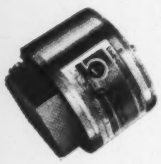
MODEL 758

MODEL 724

MODEL 708

OUTPUT CODE	MODEL NO. @	TOTAL CAPACITY	RESOLUTION PER TURN	DIMENSIONS DIA. x LENGTH
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	743	13 bits (8192)	128	2" x 3 13/32"
SERIAL BINARY (LINEAR)	707	7 bits (128)	128	2" x 2 49/64"
	713	13 bits (8192)	128	2" x 3 13/32"
	717	17 bits (131,072)	128	2" x 4 13/16"
	719	19 bits (524,288)	128	2" x 4 13/16"
SERIAL BINARY (SIN-COS)	757†	7 bits per quadrant* (4 quadrants)	512	2 1/4" x 4 1/16"
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	724	20,000	200	3 1/16" x 4 27/32"
	733	3,600	200	3 1/16" x 4 27/32"
	734	36,000	200	3 1/16" x 6 3/8"
	735	360,000	200	3 1/16" x 6 3/8"
GRAY	708	8 bits (256)	256	3 1/16" x 1 15/16"

@All models available with internally mounted isolation diodes for sequential multiplexing applications.

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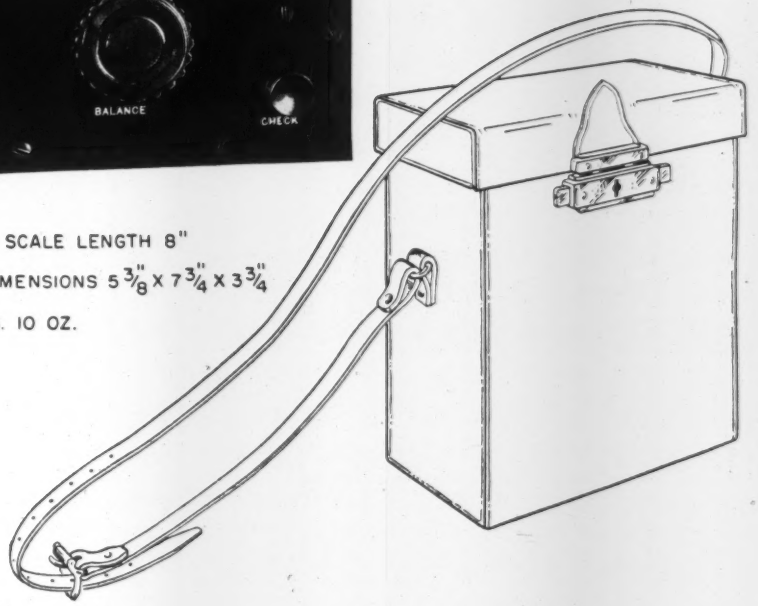

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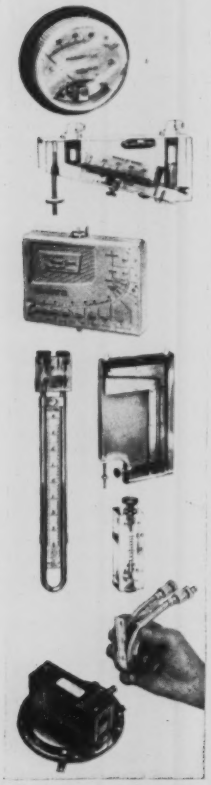

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INSTRUMENTS AND CONTROL SYSTEMS

Formerly INSTRUMENTS and AUTOMATION

MAY 1959

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Digital Printers, 700

SURVEY reveals the large range of abilities available—from solenoid-actuated desk-top adding machines to high-speed, electronic-image devices that can operate in-line with fast computers

Tape Printer Applications, 708

WILLIAM R. BEALL—incorporating solenoid actuators and an output commutator in a standard adding machine printer permits use of a low-cost data link

Definition Of Accuracy Of Voltage-To-Digital Converters, 710

BERNARD M. GORDON and IRWIN M. STONE—accuracy of a voltage-to-digital converter involves five terms

Small Digital Systems, 711

WILLIAM GROSS—small systems have advantage of low cost and high reliability, but disadvantage of low speed and low capacity

Magnetic Tape Equipment, 712

SURVEY includes recorder/reproducers, degaussers and erasers, tapes and tape testers

Acoustic Sensitivity of Accelerometers, 720

ALVIN B. KAUFMAN—fictitious vibratory acceleration signals can be produced by acoustic noise

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NORBERT E. WEBER—difference appears small—but is significant, particularly in cost

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R. C. MCNEILL—development of hydraulic load cell in force and load measuring systems

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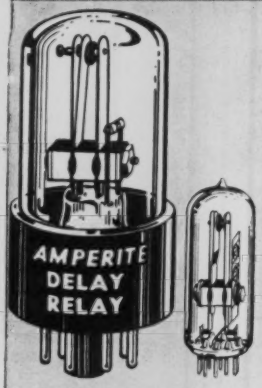

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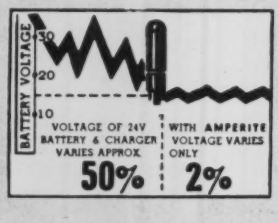

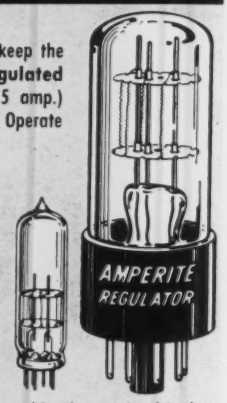

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For more information on AB-51 circle **192** on inquiry card.

INSTRUMENTS AND CONTROL SYSTEMS

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PRINT ORDER THIS ISSUE: 30,490

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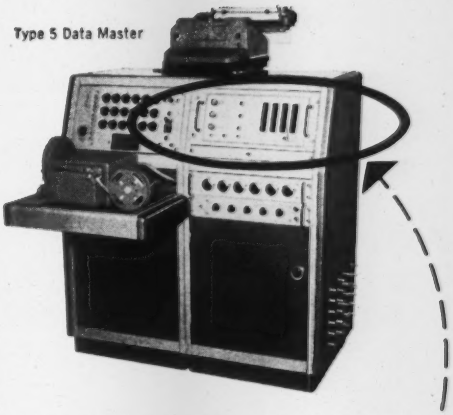
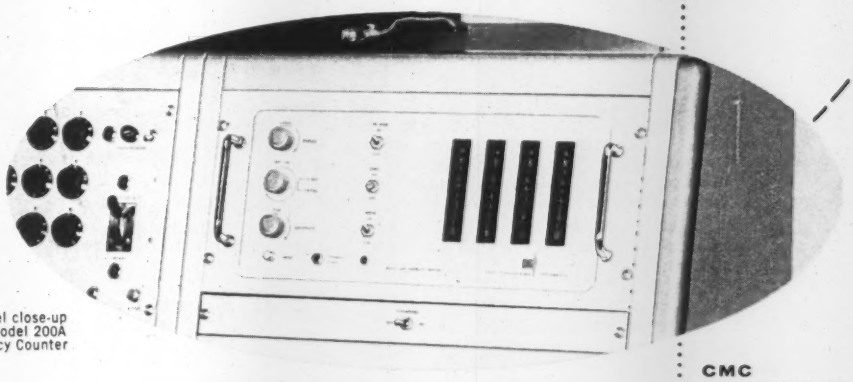
why h-g-b uses CMC electronic counting equipment


Type 5 Data Master

FOR RELIABLE FREQUENCY MEASUREMENTS


Control panel close-up showing CMC Model 200A Frequency Counter

Hanson-Gorrill-Brian, Inc., Glen Cove, New York, manufactures automatic data recorders for engine test stands, refineries, wind tunnels, etc. The Type 5 Data Master® shown above is a pressure logging device capable of scanning a number of pressures at rates up to 4 points per second, measuring them with an accuracy of ±0.25% and recording the data in digital form on punched tape, cards, etc. Frequency counter requirements for the Data Master® system demand extreme reliability, coded output, simple operation and rugged construction. To fill these requirements, the CMC Model 200A was selected.

In operation, the CMC Model 200A measures the frequency of an FM oscillator for a given gate time. This gate time is determined and selected by the Data Master® programer to enable the CMC counter to read-out directly in ppsi regardless of the pressure range. At this point, *reliability* of the frequency counter is the key factor, for if the output of the FM oscillator is miscounted, direct inaccuracies are generated throughout the entire system.

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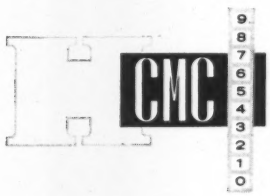

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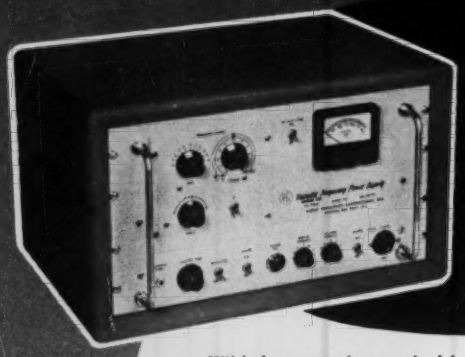

MODEL 150
features
VARIABLE FREQUENCY OUTPUT
380-2400 cps.

With front panel control of feedback for improved load matching, the Model 150 provides 150 volt-amperes for 1.0 to 0.7 leading or lagging power factors. Consuming about 450 watts from a nominal 115-volt 50/60 cycle line source, its output voltage is adjustable from 105 to 125 volts (0-130 volts as a power amplifier). Output voltage regulation is ±2% for load or line as an oscillator (as a power amplifier, regulation is dependent on feedback control setting and power factor of the load).

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Output frequency variation due to rated line and resistive load changes is less than 0.1% ±2 cycles. Frequency variation due to a change of 100 VA of reactive load is about 0.5%.

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For Owners of the RFL Model 829 AC-DC Instrument Calibration Standard

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The cart is made of heavy gauge sheet steel and is equipped with free rolling, swivel casters. Usable inside space is 33" wide x 16-1/2" deep x 26" high. One side accommodates standard 19" wide panels to meet RETMA rack standards; the other side has 24" wide opening for equipment mounted in cabinets, such as the Model 150. Interior shelf is adjustable in any position from top to bottom. Accessory, drop-leaf work counter, attachable to either side of the cart, is also available.

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For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

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Boonton, New Jersey, U.S.A.

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to the editor

Editor, I&CS:

Your recent editorial "Anti-Hardwarism" was very interesting; I have the following comments:

The Arizona State University at Tempe gives an engineering course in electrical measurements. Starting next fall a course in engineering instrumentation will be given which is designed for engineers other than electrical engineers, which has an afternoon of laboratory work per week. We hope to use real instruments in the laboratory, in lecture demonstrations, in graduate work, and in current research projects rather than the "toothpicks and wooden blocks" mentioned in the editorial: however, as pointed out in the editorial, instruments do cost money.

For our purposes it is not necessary to have the latest model so long as it works satisfactorily. If the instrument industry really wants to assist in this program, and incidentally take some income tax deductions, we would appreciate concrete evidence in the form of hardware, any hardware under 500 lbs. or 36 cu. ft. per unit (toothpicks and wooden blocks excluded).

Dr. James C. Coe
Engineering Department
Arizona State University
Tempe, Arizona

We are forwarding this letter to most major Instrument manufacturers with the following comment: "Most of the money you are spending today on education is ending up in calculus courses—here is a chance to get *your instruments* studied."

Editor, I&CS:

Congratulations on your editorials in both the February and March issues of *Instruments and Control systems*. I am in sympathy with your side of this question. However, if the editorial did nothing more than to stir up some of the dust that has settled over the years in the minds of those responsible for curriculum changes, it has served its purpose.

I do some teaching on a part-time basis in the Technical Institute Program in Connecticut. I am happy to say that Connecticut, in my opinion, recognizes the problem. This is a step forward here.

With this in mind, I request a few

reprints of the editorial for distribution among those in the educational system. I think that such an expressive article will do much to stimulate further study on the subject here in Connecticut. I also request, if possible, another copy of the March issue for my files.

Richard Schaefer
Greist Products
New Haven 15, Conn.

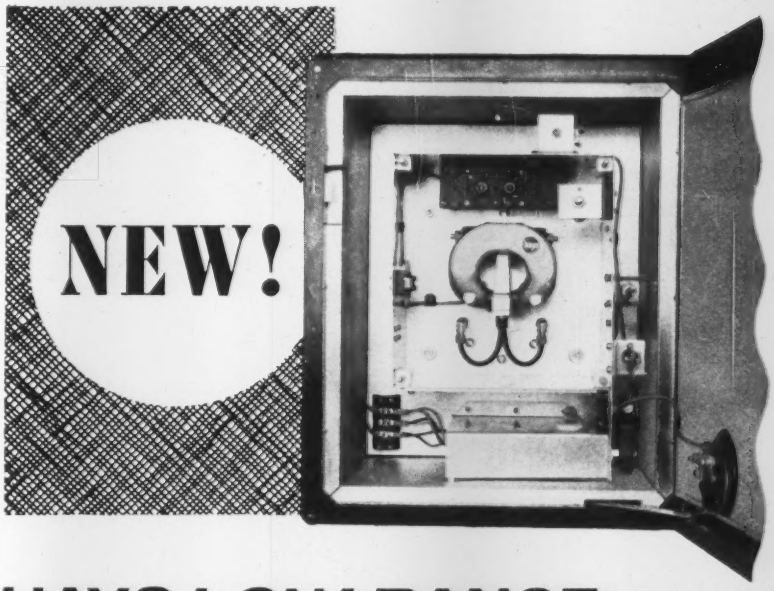
Editor, I&CS:

Your editorial on Anti-Hardwarism is one of the most thought-inspiring pieces of literature on the subject of technical education that has been written in a long, long time.

I agree wholeheartedly with your condemnation of the inadequate philosophy which you call Anti-Hardwarism. I, too, feel that the future of our nation is endangered by serious weakness in the field of education, not the least of which is the prevalence of just such philosophies as you describe.

I would like to call your attention to an educational endeavor which follows a more practical approach than is normally taken. This program is based upon the kind of philosophy which, I assume, you will applaud. I am referring to an effort by an ISA Task Force to catalog and classify on-the-job functions of instrumentation technicians. This program, we hope, will help us in recommending realistic programs for training instrumentation technicians. We are making a study of technicians in relation to hardware: what they do with hardware: and how often they do these things. Based on this study, we will attempt to determine what training it takes to fit a man for these job functions. We have prepared a questionnaire by which we will survey approximately 500 industrial plants. We hope to resolve our findings from this survey into concise definitions for each of various types of technicians.

Perhaps our study will result in something that will be even more helpful than recommendations for training program curricula. Perhaps it will bring to light a true picture of the job functions which the category of worker whom most of us call a technician really performs. Perhaps many people will be surprised to learn how few men fit the description of the technician that is in the minds of the educators when they use this term. For further information on ISA's Task Force on Instrumentation



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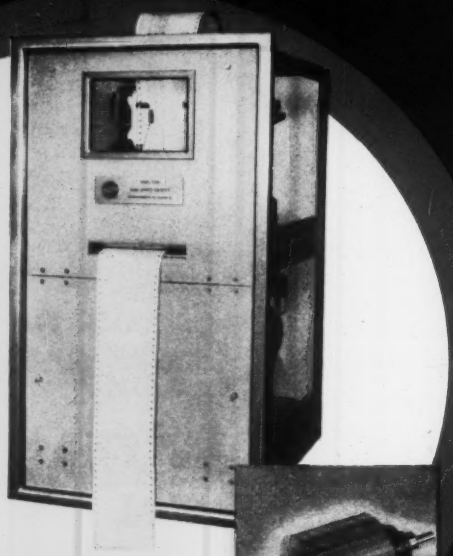

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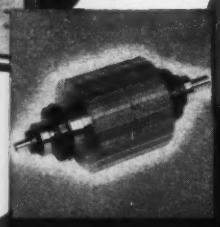

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LETTERS—CONTINUED

Technicians, and its survey, please write to U.E.L., 3947 Park Dr., Lou. 16, Ky.

Abner G. Hathaway
United Electronics Laboratories
Louisville, Ky.

Good luck—but "technicians" perform as many different tasks as there are industries, areas, and specialized professions. The good "technician" course should have as much theory AND hardware as can be taught and assimilated.

Editor, I&CS:

"Anti-Hardwarism-etc." was an interesting editorial view. You may be right that we professors are slow to accept modern instruments in our labs. Do you blame us when our experience has taught that usually those who graduate from well instrumented labs seem to know little of basic fundamentals? For instance we have just hired (with hesitancy) a well-recommended electronics graduate of our best local polytechnic school. We were dismayed in the initial interview to find he could not write the gain equation for a single stage D.C. amplifier, nor could he begin to derive it. He did turn out to be a good screw-driver mechanic. Other applicants have turned out similarly.

Unlike the high schools you mention we do have some money to spend for instrumentation. And to your pleasure we are increasing our inventory of "modern instruments" and are gradually retiring the "old."

One point however that we are constantly beseiged with was not mentioned in your editorial: the attack by industry to sell us their best instruments—and frequently when asked about their lower quality instruments we are told none is offered.

For classroom demonstration of basic principles why must we pay the price of a .01% voltage calibrator if a 10% will do? But who manufactures a 10% model? The same "thinking" exists regarding more complex equipment: oscilloscopes, frequency generators, etc. Our recourse has been to buy Heath kits, Eico kits, Knight kits, etc. We feel that the big names of quality equipment are losing out by not offering a line of poorman's equipment. And if they advertised accurately the limits of such equipment they should not be offended by offering a low grade line. Industry's greatest advantage would be to keep

the big names before the students' eyes.

"Russian Instruments, etc.," an article that followed your editorial, sounds like good news to us. In spite of the propaganda hazard we may have to look twice at what they offer if American industry can't lower themselves to meeting our needs—quality wise and consequently price wise.

Incidentally two big names have taken steps to solve the problem without reducing quality: Tektronix (pulse generators and waveform generators), and Weston (tube testers and certain meters). Their expedient: a special price reduction to educational institutions.

Edmund H. Brand
University of Washington
Seattle 5, Washington

We answered Mr. Brand as follows

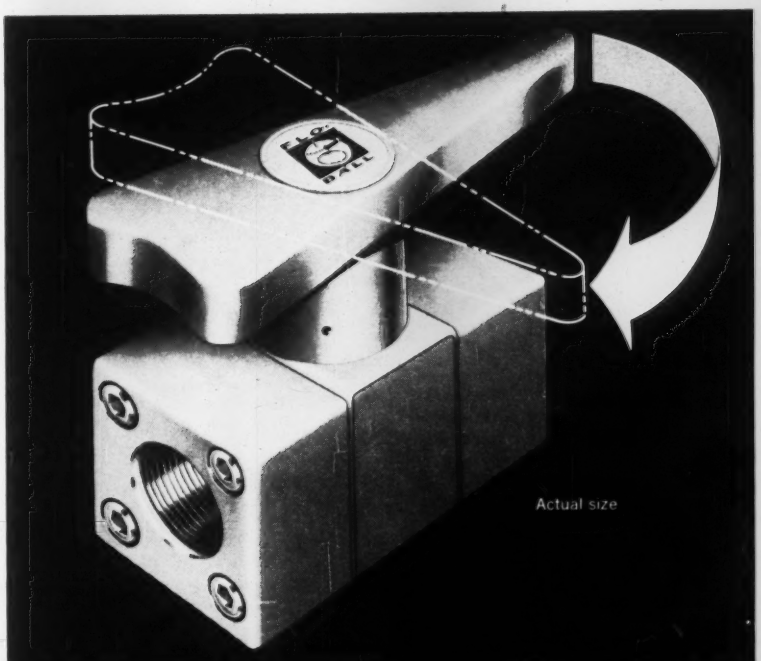
Dear Mr. Brand:

Of course no one can blame you either for not using expensive instruments for which you have no funds, or for not respecting a good technician with little theoretical background. A technician with no theoretical background is like a theoretician with no technical ability—each is only half developed. But neither of the situations you describe are pertinent to our discussion on "Hardwarism."

Our argument is only with those university personnel whose anti-hardware philosophy is so deep that it prevents them from supporting any education experiment that attempts to use instruments. I documented how this philosophy operates in practice, naming names. Even the reaction to my discussion only proves how deep this philosophy has penetrated, and how difficult it will be to get "modern instruments" into the real trouble spot—the high school. It is the high school which needs the instruments most—it is the university that directly and indirectly prevents the high school from getting them (even while using instruments itself). This is easily done as the university controls how most funds are spent at the public-school level.

Your suggestion that classroom-quality instruments are needed is an excellent one. I am preparing an editorial on it—see page 699. Orchids to Tektronix and Weston: the latter has been very progressive in education for many years.

The debate above rages on next month!!—ED



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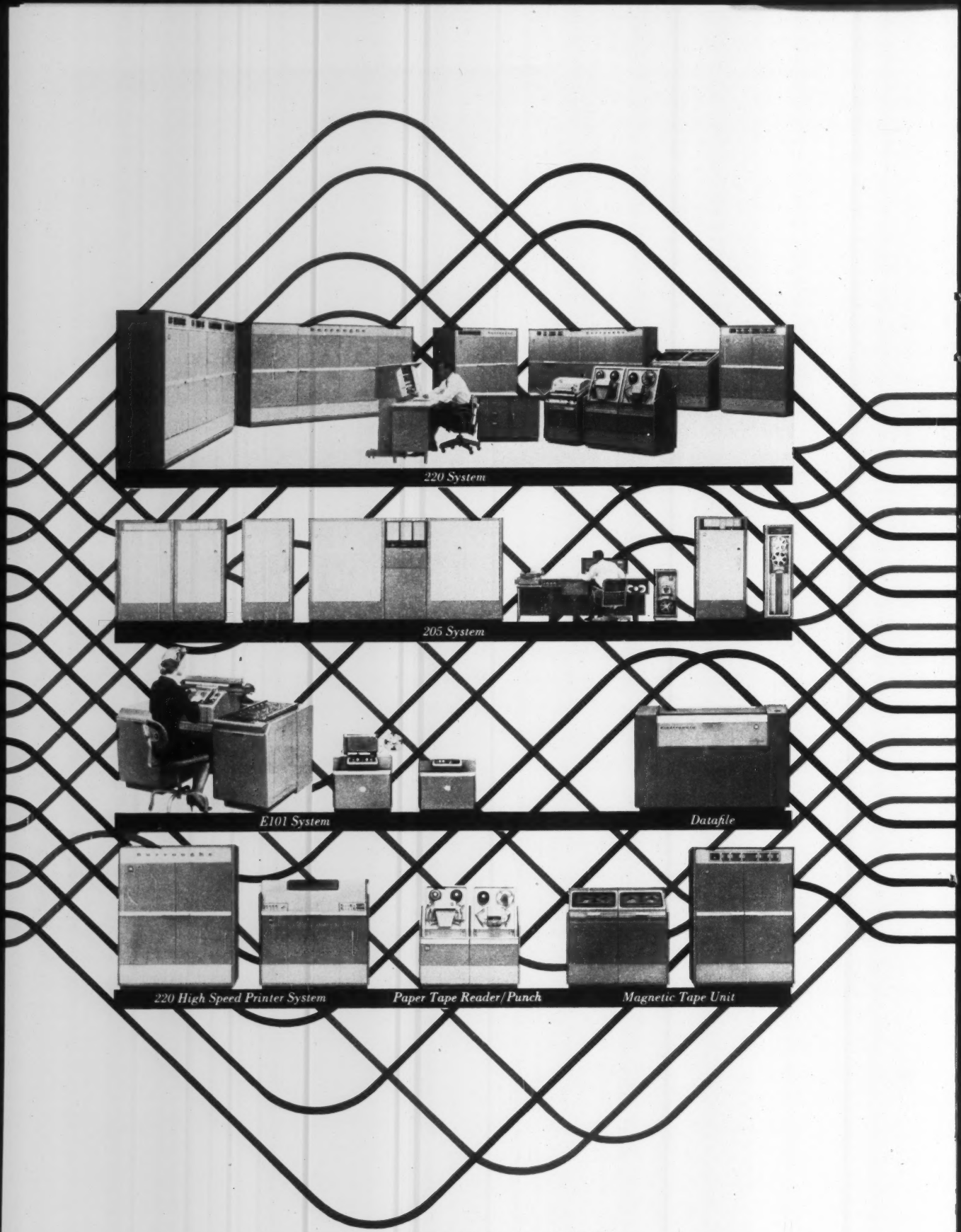

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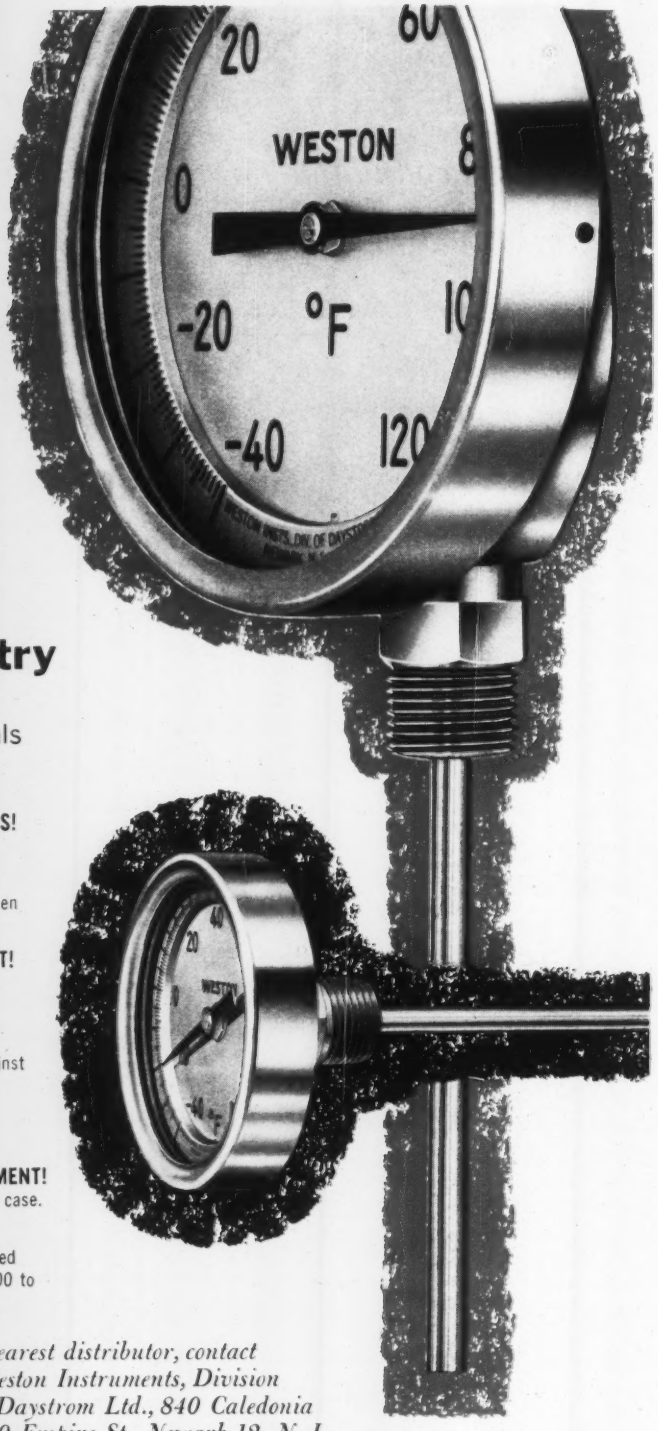

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reader inquiries

Electric-Instrument Repair Manuals

Group of electric meter repair men wishes to receive repair manuals. A-390

High-Pressure Viscometer

Professor of mechanical engineering working on a lubrication research project seeks high-pressure viscometer for mixtures at pressures up to 3000 psig. A-391

Impulse Readout

President of company manufacturing automatic weighing units seeks "instrument capable of receiving electrical impulses at a varying rate of 1 to 10/min and converting this to a digital readout of the hourly rate at which these impulses are received." A-392

Instrument Repair Service

Importer of refractometers, polarimeters, spectrometers, and spectrographs seeks reputable shop for the repair of these British-made instruments. A-393

Kornfeld Apparatus

British import house seeks Kornfeld apparatus for determining dynamic hysteresis loop when vibrations are forced (with optical device), or the corresponding apparatus according to German DIN 53513 Standards. Also: Air flotation stoner, gravity separator, feed hopper, and transformer for 230-v, single-phase, 50-cps operation. A-394

Environmental Test Chamber

British import house seeks environmental chamber for testing hardboard at temperature range from 20 to 100°C and relative humidity of 0 to 100%. Chamber should be equipped with device for testing elongation, swelling and deformation of specimens. A-395

Pressure Instrument

Supervisor of electric system lab seeks pressure instrument that can produce sinusoidally-varying output, suitable to determine response characteristics of pressure transducers (range 100,000 ft altitude), with adjustable frequency and amplitude, and very low distortion. A-396

Underwater Gravimeter

Canadian exporter wishes to identify "Robert H. Ray Co., U. S. A.," makers of an underwater gravimeter. A-397

Teflon Tubing

Canadian instrument manufacturer is seeking sources of supply for small-diameter Teflon tubing. A-398

Pinhole Detector

Molders of plastics in Argentina seeks spark-type pinhole detector to check steel tanks lined with reinforced polyester resin. A-399

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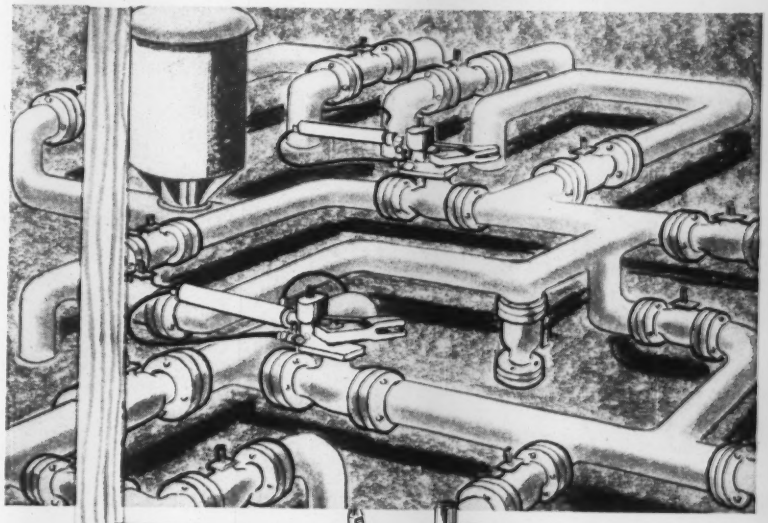

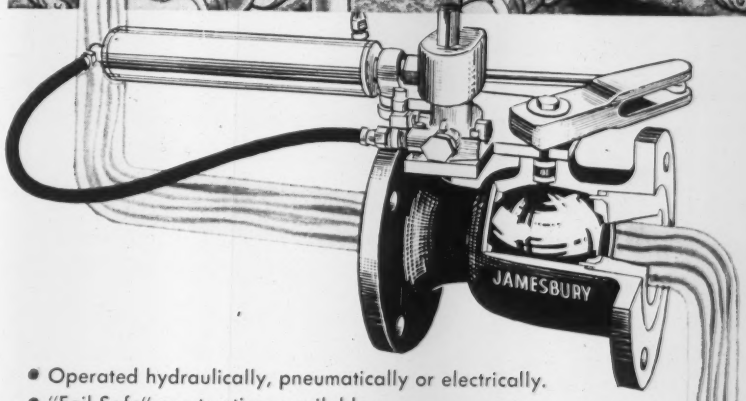

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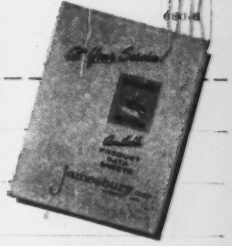

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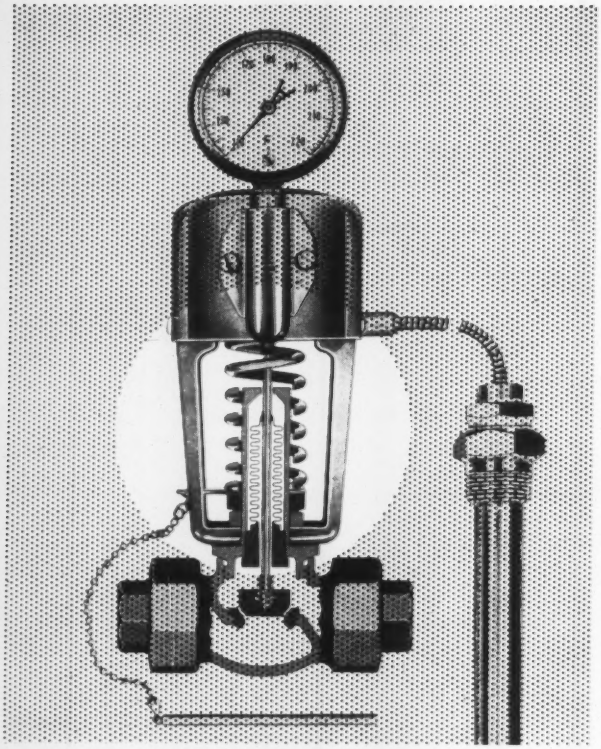

A friction-free bellows seals off the valve stem on the new American Temperature Regulator. Result: no stem binding to retard valve action, fastest possible temperature response.

The bellows seal makes practical a friction-free, nonleaking packless valve that needs no lubrication. This innovation plus an extra-long, preflexed adjusting spring marks the new American Temperature Regulator as the fastest acting, most stable available. Corrective action starts at less than 1/10 degree change at the bulb. And the adjusting spring allows unusual latitude in temperature settings.

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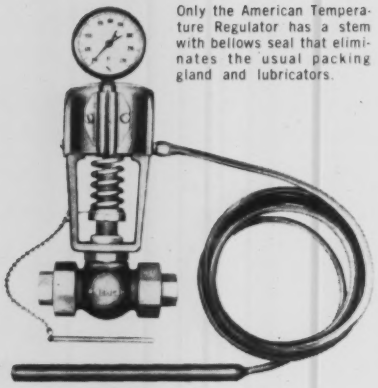

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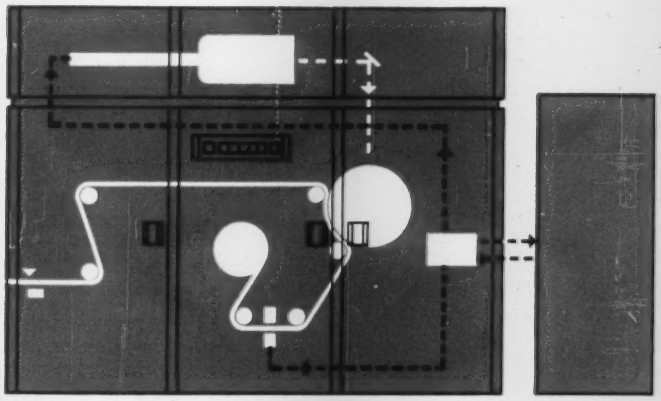

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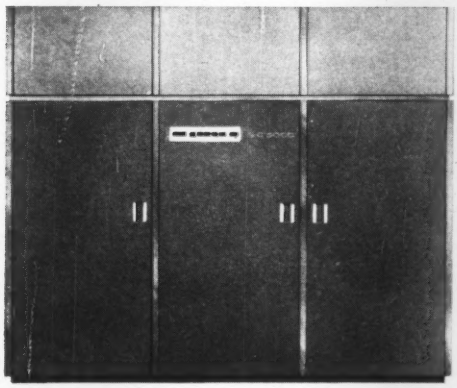

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And the advantages of Dekoron Protecto-Pac multiply the closer you examine them. For example, you can get Protecto-Pac in many forms to suit your requirements exactly — *from stock.*

If there is danger from weld splatter, sparks or a potential fire hazard — order Dekoron Protecto-Pac Type FB. If you wish to bury it underground — specify low-cost Protecto-Pac Type B. Both types supplied with virtually any number of individual tubes, and also with *new metal armor protection.*

You can pay more but you can't buy better, longer-lasting instrument line harness than *Dekoron — America's Premier Instrument Tubing Line.*

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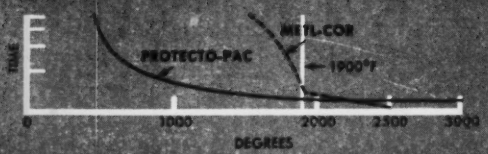

FIRE RESISTANCE of copper tube bundles is superior up to 1900°F, less pronounced from 1900° to 2500°F. Above 2500° Protecto-Pac Type FB is superior to copper tube bundle.

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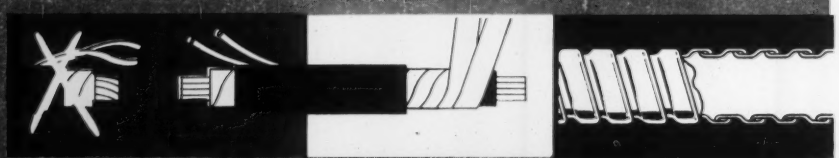

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Magnetic tape market will reach $40 million in 1959, says F. Rogers, Jr. V. P., Reeves Soundcraft.

Magnetic amplifier market is now $125 million annually, says H. Herz of Magnetic Amplifiers, Inc., and "should" reach $2 billion before 1970.

Infrared market, which was only $5 million annually two years' ago, is now about $15 million yearly, says Electronics magazine. Twelve railroads are now using infrared temperature detectors to spot boxcar bearings.

Ultrasonic market was $25 million in 1958 says Narda Ultrasonics, "should" hit $50 million in 1959.

Selenium rectifier market should exceed $22 million in 1959 (compared to $26 million in 1958). Present market includes $18 million industrial, $5 million home entertainment.

Silicon diode and rectifier market will exceed $50 million in 1959 says W. Deutsch of ITT (compared to $26 million in 1958). Zener diode sales will be about $9 million of total.

Parametric amplifiers for low-noise microwave amplification is growing field (owing to space communications). Parametric diodes were introduced recently at $150; price already has fallen to $35.

Russian instrument production between 1950 and 1957 increased 5.2 times, says K. Arutyunov in January issue of British LLU (Lending Library Unit) Translations Bulletin. Also, 32 new instrument manufacturing plants are contemplated; Russian instrument industry "must" quadruple in period 1959-65, which figure includes a tenfold increase in both controlling mechanisms and computing equipment.

Transistor sales are expected to reach 350 million units per year by 1963 (three times the 1959 total), with sales of $300 million. About 80 firms are now in transistor production.

NSF estimated that full-time college faculty numbered 196,000 in 1956; by 1970 number "should rise" to 495,000 to meet needs. Number holding Ph.D. degree is now 41% of total; is expected to drop to 20% by 1970 owing to recruiting efforts of industry and government (i.e., lower pay of college jobs).

Binocular manufacturing industry of Japan, largely an export operation geared to the American market, has expanded rapidly in recent years, and continues to grow, says BDSA, Department of Commerce. The industry is composed of approximately 216 manufacturing firms, of which 90 percent employ less than 30 workers, and 95 percent are capitalized at less than $14,000 each. Total output exceeded 1.5 million units in 1958. United States purchases two-thirds of total.

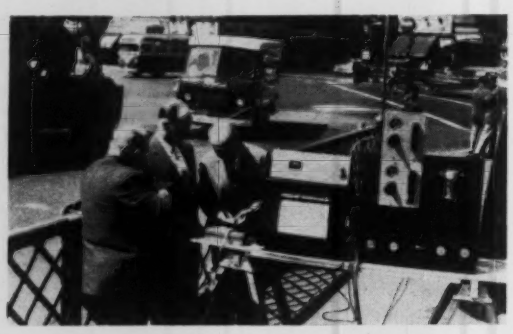
In 1957 more than 150,000 persons were employed in atomic energy, including 9000 scientists and engineers privately employed.

US will have 1,700,000 engineers and scientists by 1980.

news

CO Traced to Auto Fumes

NEW YORK, N. Y.—The laboratory for the Department of Air Pollution Control of New York City has successfully used a Mine Safety Appliances LIRA infrared analyzer for continuous, accurate measurement of carbon monoxide and other exhaust contaminants directly at the source. Street-site tests have traced monoxide to concentrations as low as one part per million. Other unburned products from automobile exhaust pipes can be measured with the same precision.



Results of the first series of tests showed that concentrations of contaminants found at street level were three to four times higher than those detected by a test station at a higher location. Peak contaminations correspond with the rate of traffic density.

Picture shows (l. to r.) Dr. William P. Yant, director of research for Mine Safety Appliances Co; S. L. Hanauer, deputy commissioner of Department of Air Pollution Control; and Dr. Leonard Greenburg, commissioner of the Department.

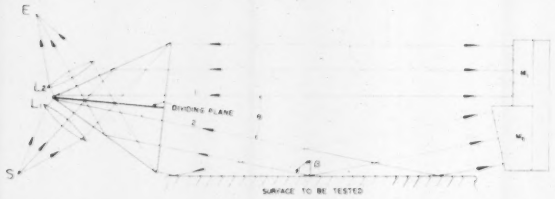
A Network of Computers

WASHINGTON, D. C.—NBS has been investigating the logical problems arising when several high-speed electronic computers are connected together to work on common large-scale tasks. Many large-scale data-processing jobs, for which solutions are now urgently required, call for much faster computing capabilities then presently available machines can provide. In organizing such a network, many logical problems are encountered that do not ordinarily occur in the usual single-computer system.

One significant result has been the design of the new NBS Pilot Data Processor, a multi-computer network. The system is made up of several independently operating units that run concurrently, and which can exchange data and instructions. It contains a primary and a secondary computer, and a third independent computer which specializes in operations that control and interpret the data flowing between the system's internal memory and its external storage and display devices.

Interferometer Tests Large Surfaces

WASHINGTON, D. C.—A simple interferometer for testing the flatness of large surfaces has been developed by the National Bureau of Standards. The instrument examines surfaces by producing a set of interference fringes, in effect, a contour map of the test area. As the only other known interferometric device for investigat-



ing large areas (a Russian design) is extremely complex, the autocollimator is usually employed in flatness measurements, although it is less accurate.

In interferometers previously used for measuring flatness, a one-fringe departure from straightness corresponds to a surface departure from flatness of $\lambda/(2 \cos \beta)$, where λ is the wavelength of the light and β is the angle of incidence. In the present instrument, because light is reflected twice from the surface, the sensitivity is double that of conventional interferometers. Consequently even though the sensitivity is lowered by increasing the angle of incidence to cover long surfaces, it is sufficiently high for present requirements.

ASA Sectional Committee X2, Office Standards, is studying the maximum permissible levels of interference of electric business machines with radar sets, television, x-ray apparatus, and other electric and electronic devices.

HAGAN CHEMICALS & CONTROLS will start its customer training sessions in the fourth annual summer series on control and instrumentation at the University of Pittsburgh, June 9, 1959.

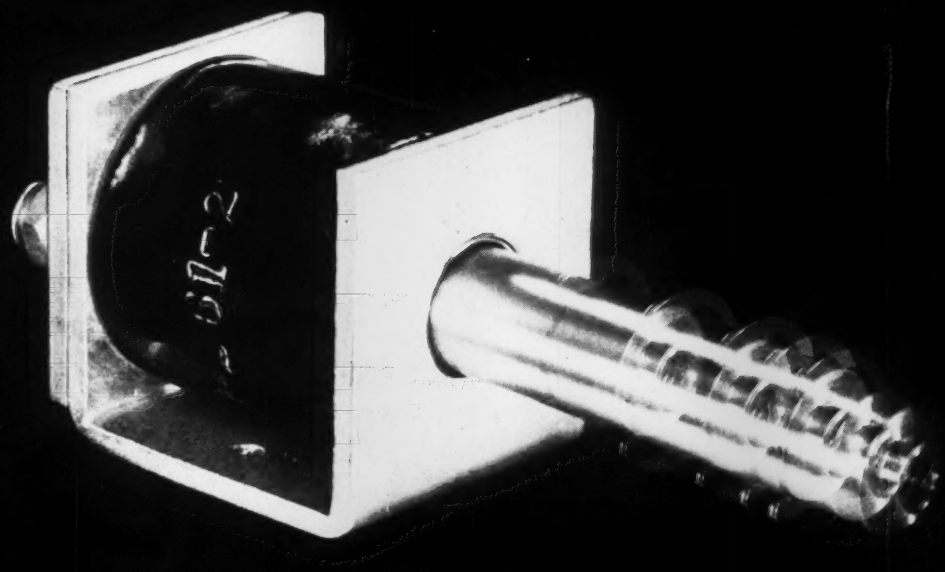
SUN OIL CO. and **GENESYS CORP.** have announced a joint development program of advanced petroleum refining instrumentation, aimed at greater efficiency. Sun's Product Control Center at its Markus Hook, Pa., refinery will be the first facility to use it, collecting plant operating data and continuously monitoring variances of the product streams.

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION has scheduled six Summer Institutes on Nuclear Energy for engineering educators to provide special training in the fields of nuclear energy and the nature of nuclear reactor problems.

AEC has developed SNAP 111, a five-pound device 4¾" in diameter and 5½" high, for converting the radiation emitted by 1/3 of a gram of radioactive material into 5 watts of electricity.

FRANKLIN ELECTRONICS now offers a complete digital instrumentation engineering service for the electronic and missile industries at its Van Nuys, Calif., site.

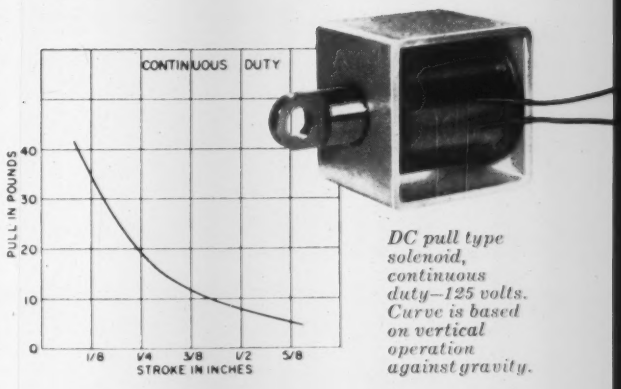
100 MILLION OPERATIONS!



new ASCO solenoid has virtually unlimited life!

This is ASCO's new long-life solenoid. Unlike ordinary solenoids where plunger rides loosely in the sleeve this device is precision manufactured to tolerances of ± .0005". A rugged machine tool bearing guides plunger to provide accurate, smooth stroking. There is virtually no wear—almost unlimited solenoid life.

If your application calls for a precision solenoid that must operate consistently and indefinitely, investigate this new long-life ASCO design. ASCO solenoids are available to meet a wide variety of applications. For additional information contact your ASCO engineer or write for Catalog 57-S5.



DC pull type solenoid, continuous duty—125 volts. Curve is based on vertical operation against gravity.

Automatic Switch Co.

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AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

For more information circle 19 on inquiry card.

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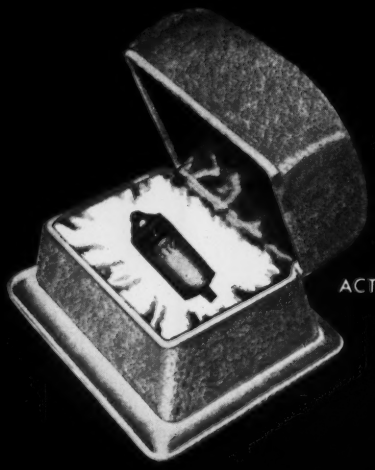
Another Engineering Triumph



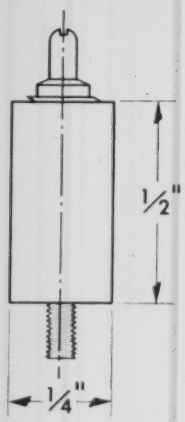
ACTUAL SIZE

From CENTURY of Tulsa

SERIES 60000

TRANSISTOR SIZE PRESSURE SWITCH

WEIGHS ONLY ¼ OUNCE!



SPECIFICATIONS

PRESSURES

Setting Limits: 1 to 100 psig

Operating Range: 1 to 500 psig

Proof Pressure: 3000 psig

Burst Pressure: 5000 psig

ELECTRICAL RATING

Contact Resistance: Less than 0.1 ohm @ 5 milliamperes

.1 amp. inductive at 28 V d-c

.2 amp. resistive at 28 V d-c

Insulation Resistance: Greater than 5 megohms @ 325 VAC RMS

Electrical Connector: Solder on terminals.

Contact Arrangements: SPST

Mountings: Direct on pressure port

Pressure Fittings: ⅛"

Weight: ¼ oz.

Temperature: −65° F. to +160° F.

. . . from the engineers who created the first direct writing oscillograph, the first sub-miniature galvanometer, comes this transistor size pressure switch for surge, leak, and variance detection in all types of systems. Now in use as automatic leak detectors on missile programs. Our engineers are ready to assist you in the application of this new sub-miniature pressure switch to your systems.

Send your problem statement for our recommendations.

Century OF TULSA

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PHONE LUther 4-7111

Represented in all principal cities of U. S. by the Garrett Corporation Airsupply and Aero Engineering Divisions

In Canada by Garrett Manufacturing Corporation of Canada, Ltd.

For more information circle **44** on inquiry card.

NEWS—CONTINUED

TEXAS INSTRUMENTS has been awarded a contract in excess of $100,000 to provide a Data-Gage digital code transmission system for an oil well lease processing unit to be located on Lake Maracaibo, Venezuela.

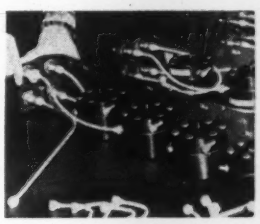
Accuracy of the Data-Gage system has received its certification by the fact that *Sun Oil Co.* has approved its use for volumetric measurements of daily inventories of liquid levels in approximately 100 oil tanks at the Marcus Hook refinery. The Data-Gage system allows readings to the nearest sixteenth inch.

ASA, Miscellaneous Standards Board, has recommended that a special committee be set up to study the practical value of reaffirming the American Standard for inch-millimeter conversions as exactly 25.4:1 following the recent announcement of the standards laboratories of Australia, Canada, New Zealand, South Africa, United Kingdom, and the United States to have this factor go into effect by July 31, 1959.

GULF OIL CORP. recently opened a new wing for electronic data processing equipment at its main research laboratories. It includes an IBM 704.

GE has successfully used a thermionic direct energy converter at the Vallecitos Atomic Laboratory to produce enough electricity from a small strip of radioactive gold to operate a radio transmitter. Method has low efficiency as yet.

GE's Thermionic Direct Energy Converter



Polyamide Tubing Used In Pressure Measurement

POLYMER CORP.'s polyamide pressure tubing "Nylaflow" forms an 800-ft long maze in a new "Digital Multiple Pressure Measurement System" developed by Fischer & Porter which simultaneously measures up to 300 pressure points on jet engines with automatic digital recording. Savings over copper tubing are said to be in the neighborhood of 50%.

M. W. KELLOGG CO. will have a Burroughs "205" computer at the Petroleum Congress Exhibit in June demonstrating calculation of a cascade sulfuric acid alkylation unit, computation of material balances around a complete gas recovery system, and designing a heat exchanger. The "205" will be lent to Kellogg by Burroughs.

MID-EASTERN ELECTRONICS announces a plan whereby customers can lease equipment for a year at the rate of 10% of the normal purchase price per month with an option to buy it for an additional 10% of the price.

GE has a new rental program to lend customers instruments from a pool of 13,000 constituting 250 different categories, and will charge fees ranging from $1 to $96.

BRISTOL special charts for railway traffic control

Using control equipment developed by Union Switch and Signal Division of Westinghouse Air Brake Company, Swissvale, Pa., one railroad dispatcher can direct the movement of trains over hundreds of miles of track.

One key feature of this streamlined dispatching equipment is the Union Automatic Train Recorder that indicates—on a custom-printed Bristol chart that you can see in the dispatcher's desk top above—the times that trains pass up to 57 specified locations.

The Bristol special chart used here is one of hundreds of special charts engineered and printed to instrument manufacturers' special requirements.

Do You Have a Chart Design Problem?

Backed by well over 60 years of chart-printing experience, The Bristol Company is the only instrument manufacturer with facilities to print charts for other instrument makers. The entire Bristol chart engineering service is at your disposal to assist you to design the best possible chart into your system.

Bristol can furnish you with charts for ink, electrical, heat, pressure, or light-beam recording.

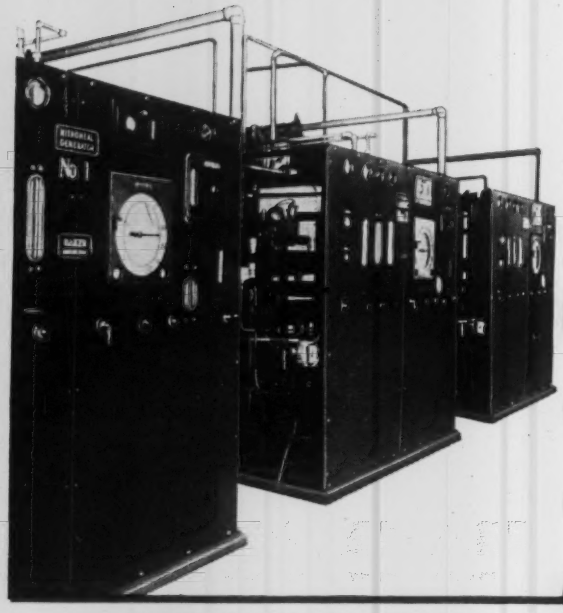
Write for Bulletin Y1906 for complete details on Bristol's extensive chart-engineering facilities. The Bristol Company, 154 Bristol Road, Waterbury 20, Connecticut. o 2

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **21** on inquiry card.

for the most efficient production of oxygen-free gas

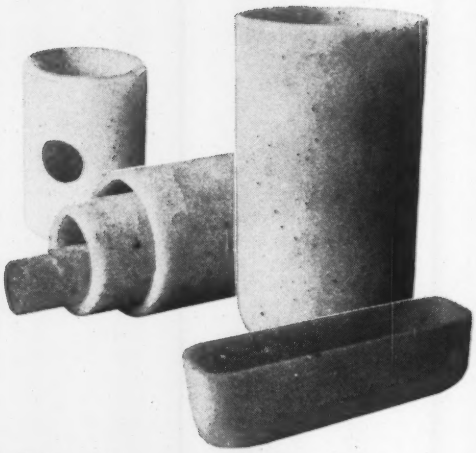


NITRONEAL® GAS GENERATOR

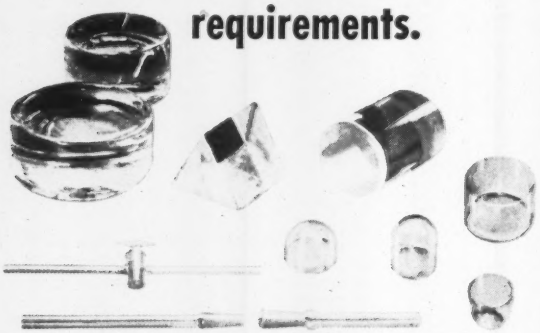
. . . provides by far the most economical and efficient method for the production of pure nitrogen —*completely free of oxygen*—and with hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Nitrogen is supplied at a fraction of cylinder supply cost.

The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. Units can be supplied in capacities of 100 cfh to 10,000 cfh. . . . The catalyst lasts indefinitely—maintenance costs are practically nil. Write for complete catalog material and data.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.



look to Amersil for all high purity fused quartz requirements.



Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission applications, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements. Send for bulletin.

AMERSIL QUARTZ DIVISION • 685 RAMSEY AVENUE
HILLSIDE, N. J.

CHEMICAL DIVISION

WRITE FOR LITERATURE

AMERSIL QUARTZ DIVISION

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ DIVISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BAKER REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL, ENGELHARD INDUSTRIES, LTD. LONDON, ENGELHARD INDUSTRIES A. G. ZURICH, ENGELHARD INDUSTRIES PTY., LTD. MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGOTA, INDUSTRIE ENGELHARD S. P. A. ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPLATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U.S.A.

For more information on Gas Generator circle **22** on inquiry card.

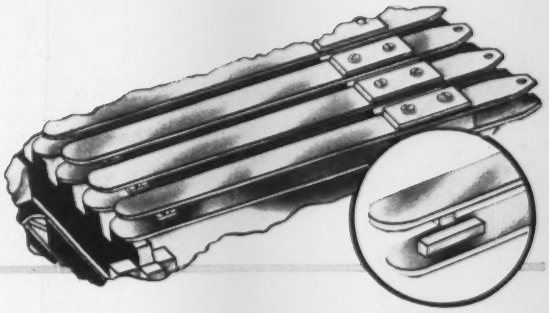
For more information on Fused Quartz circle **23** on inquiry card.

a simplified mirror-bright silver plating process

Here is the most efficient, simple procedure to protect electrical electronic and lamp components with a mirror-bright silver finish—through a complete range from flash to heavy deposit. The procedure is easy, economical and non-critical—with little or no polishing required. Silva-Brite is a clear, water-white solution, enabling the operator to observe work as it is being plated. Uniformly good results are attained with current densities ranging from 10 to 40 amperes per square foot. Normal room temperature operation minimizes fumes and tendency toward bath decomposition. Send for descriptive data together with detailed plating procedures.

AMERICAN PLATINUM & SILVER DIVISION
231 N. J. RAILROAD AVENUE, NEWARK, N. J.

AMERICAN PLATINUM & SILVER DIVISION



ECONOTAPE crossbar contacts are most efficient for electrical relays

You can now get ideally efficient crossbar contacts for your electrical relays—with as many contacts as you need, where you need them—with positive assurance of full, contact surface. This has been made possible through the development of Makepeace's new ECONOTAPE, a precision-drawn shaped or rectangular contact wire in either solid precious metal or in laminated metal—in your choice of gold, platinum, palladium, silver and their various alloys.

Econotape crossbar contacts are supplied complete, attached to Makepeace blades . . . attached to blades supplied by you...or Econotape for your own attaching.

Econotape is cut off and welded to the blade in one operation. It is no longer necessary to handle and attach individual button type contacts. Positioning of Econotape on the blade is done automatically as the tape is cut off and welded. Permanent attachment is assured by a homogenous metallurgical bond that is undisturbed by expansion and contraction caused by temperature changes.

If you are designing a new relay or trying to cut the cost of your present mechanism, send for Econotape Crossbar Contact literature.

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D. E. MAKEPEACE DIVISION

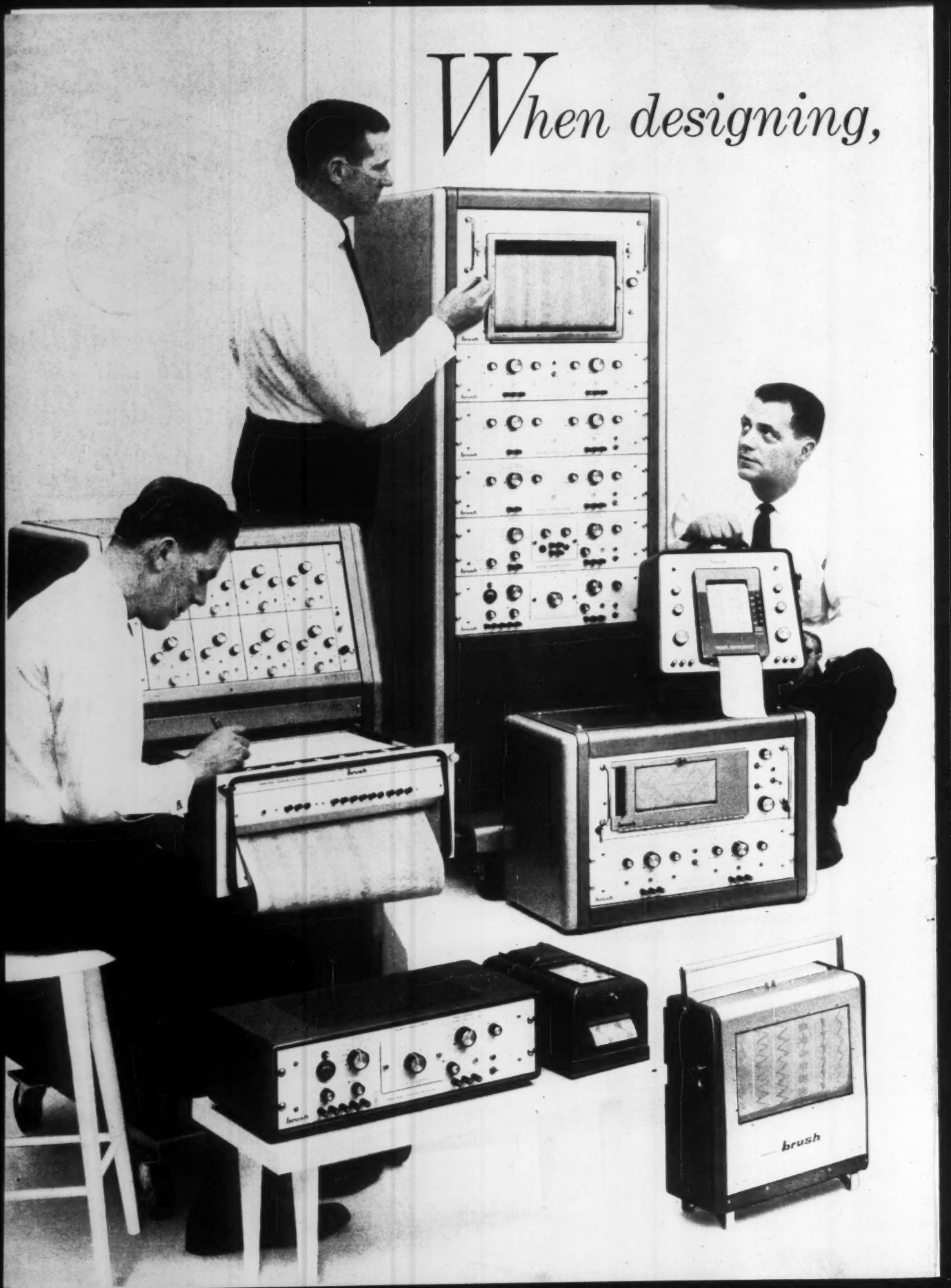
ENGELHARD INDUSTRIES, INC.

EXECUTIVE OFFICES:

113 ASTOR STREET • NEWARK 2, NEW JERSEY

For more information on Silver Plating circle **24** on inquiry card.

For more information on Contacts circle **25** on inquiry card.


When designing,
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testing or monitoring . . .

YOU CAN RECORD RESULTS BETTER WITH BRUSH

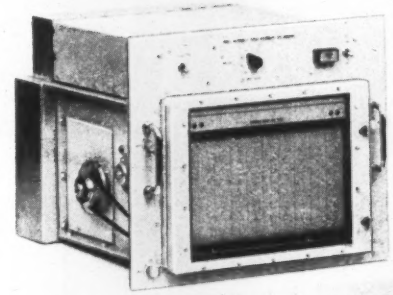
All Brush Recording Systems reflect advanced concepts in design that mean exceptional versatility, accuracy and reliability in your data collecting operations.

Your most exacting requirements can be met by these *direct writing* systems whether military or industrial. They display information *instantly*—give you precise data for quick decisions. You control the data you need, exclude the extraneous, and have optimum flexibility for future applications not yet contemplated.

Widest choice of equipment in the industry. Ink, electric or thermal writing . . . curvilinear or rectilinear readout . . . horizontal or vertical presentation . . . chart speeds from 10 inches/day to 4 feet/second . . . complete selection of amplifiers . . . rack mounted, bench top or portable configurations.

A pioneer in instrumentation since 1930, Brush has always built for ruggedness and precision. Installations are right. Operating manuals contain clearly written instructions. Your personnel are trained properly.

In designing, testing or monitoring you can get better results from Brush *Ultralinear* Recording Systems. Let's talk it over. Set a date. We'll be there.



For more information circle 26 on inquiry card.

Write for free informative booklet, "New Concepts in Recording." Contains helpful ideas and suggestions.

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DIVISION OF
CLEVITE CORPORATION
37TH AND PERKINS — CLEVELAND 14, OHIO

Factory branches, service and warehousing at Arlington, Va., Boston, Cleveland, Los Angeles, San Francisco and Seattle; engineering representatives in all key locations.

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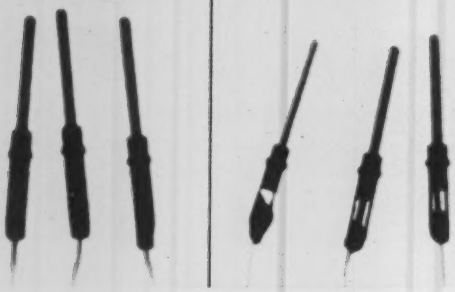


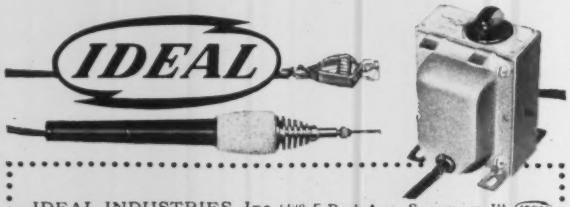
Actual X-ray Photos Show How IDEAL Thermo-Tip Resistance Soldering Tools Reduce Costly Voids in Winchester and Cannon Plug Pins

Because the whole pin is heated, "cold-flow joints" are eliminated; failures are greatly reduced

	Conduction Method		Resistance Method	
Pin No.	Length of void	% of void	Length of void	% of void
1	0.12"	40	0.00"	0
2	0.12"	40	0.00"	0
3	0.07"	23	0.05"	17
4	0.18"	60	0.00"	0
5	0.06"	20	0.06"	20
6	0.05"	17	0.04"	13
7	0.02"	7	0.05"	17
8	0.08"	27	0.01"	3
9	0.09"	30	0.07"	23
10	0.12"	40	0.09"	30
11	0.15"	50	0.04"	13
12	0.12"	40	0.06"	20
13	0.09"	30	0.01"	3
14	0.12"	40	0.08"	27
15	0.11"	37	0.02"	7
16	0.10"	33	0.04"	13
17	0.07"	23	0.04"	13
18	0.09"	30	0.09"	30
19	0.11"	37	0.10"	33
20	0.11"	37	0.06"	20
21	0.05"	17	0.01"	3
22	0.15"	50	0.00"	0
23	0.11"	37	0.05"	17
24			0.07"	23

● These production test results from a major Aircraft manufacturer prove the superiority of Ideal Resistance Soldering Tools to the best available commercial soldering irons. Voids averaged 33% with soldering irons. With resistance soldering only 14%.

In addition, higher production speeds were possible on Cannon plugs and operators were less subject to painful burns. Send for descriptive literature.



IDEAL INDUSTRIES, Inc. 1420-E Park Ave., Sycamore, Ill. (IDEAL)

Gentlemen: Please send complete catalog information about Ideal's Thermo-Tip Resistance Soldering Tools.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

For more information circle **27** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

AMERICAN STOCK EXCHANGE
Price Range 1959 through April 14, 1959

	HIGH	LOW	PRICE AS OF 4/14/59
American Meter	45 1/4	38	40
Arc Equipment	29 3/4	22 1/8	26 3/8
Barry Controls "B"	26	13 3/4	20 3/8
Belock Instruments	15 7/8	10 3/8	13 1/4
Benrus Watch	9	5 7/8	8
Breeze Corp.	9 3/8	6 1/4	6 1/4
Clark Controller	29 3/4	19 5/8	26 3/4
Clarostat Mfg.	7 3/8	4	6 1/2
Clary Corp.	10 5/8	5 3/4	10 1/2
Dalmont Laboratories	9 3/8	6	7 7/8
Dynamics Corp. of America	12 3/4	4 5/8	11
Electronics Corp. of America	16 7/8	9 1/2	12 3/4
El-Tronics	2 1/4	1	1 5/8
Fairchild Camera & Instrument	95 7/8	50 3/4	82 3/4
General Transistor	72 3/4	49	68 7/8
Globe-Union	25 1/2	20 1/4	24½-24 7/8(1)
Hazeltine Corp.	72	54 1/2	64
International Resistance	12 1/4	7	12 1/8
Lear, Inc.	15 1/4	9 1/8	14 7/8
National Research	29 5/8	15 3/8	27 3/8
New Haven Clock	5 3/8	1 1/2	4
Nuclear Corp. of America	4 1/4	1 3/4	3
Philips Electronics, Inc.	36 7/8	23 1/2	33 1/8
Pneumatic Scale	61	32	50
Servo Corp. of America	45 1/2	14 5/8	34 3/8
Servomechanisms	18 1/4	5	14 3/8
Statham Instruments Inc.	43	23	32 3/4
Victoreen Instrument Co.	15 3/8	6 7/8	13 7/8
Wallace & Tiernan	45	36 1/4	42 3/4
Waltham Prec. Instrument Co.	4 5/8	1 1/8	3 5/8

1) Not traded - Bid and Asked

New York Stock Exchange:

NEW YORK STOCK EXCHANGE
Price Range for 1959 thru April 14, 1959

	HIGH	LOW	PRICE AS OF 4/14/59
ACF Industries	56 1/4	47 5/8	53 3/8
Aeroquip Corp.	33 7/8	23 5/8	32
Allis Chalmers	30 7/8	26 7/8	28 3/4
American Chain & Cable	55 1/2	47 3/4	54 3/8-54½(1)
American Machine & Foundry	74 3/8	53 1/2	74 1/8
American Machine & Metals	85	67 1/2	85
American Optical	49 1/2	38 3/8	45
American Tel. & Tel.	250	224 5/8	249 3/4
Ampex Corp.	84 1/2	67 3/4	77 3/4
Bausch & Lomb Optical	32 3/4	27	29 1/2
Beckman Instruments	59 3/8	50 1/4	57
Bell & Howell	104 5/8	76	103 1/4
Bendix Aviation	79 3/4	66	78 1/4
Boeing Airplane	40 1/2	29 7/8	40 3/8
Bullard	20 3/4	16	17
Bulova Watch	20 5/8	13 1/2	19 1/4
Burroughs	45 3/4	36 1/4	43 3/8
Carborundum	44 5/8	37 3/8	43
Cincinnati Milling Machine	42 7/8	36 3/4	40 3/4
Clevite	35 1/8	24 3/4	34
Columbia Broadcasting System	46	35	46
Consolidated Electrodynamics	41 3/4	33 3/4	37 3/4
Consolidated Electronics	42 3/8	33 1/2	40 5/8
Cornell Dubilier	28	20 3/4	27
Corning Glass	110 3/4	89 3/4	108 1/2
Curtiss-Wright	39 1/2	27 1/8	38 5/8
Cutler-Hammer	73 3/4	59 1/2	73 3/4
Daystrom	49 3/4	34	41 1/2
Douglas Aircraft	59 3/4	50 1/8	55
Eastman Kodak	78 1/2	76 1/8	75 7/8
Eaton Mfg.	71	56 1/4	70
Electric Auto Lite	42	36 1/4	41
Elgin Watch	14	9 3/4	12
Emerson Electric	63 1/2	48 1/8	62 3/4
Food Machinery & Chemical	49 3/4	40	47 3/4
Gamewell	39 1/4	27 1/2	30
Garrett	47 3/8	30	43 1/4
General Controls	39 1/4	24	35
General Dynamics	66 1/2	58 1/2	61 1/8
General Electric	84 1/8	74 5/8	80 7/8
General Instrument	23 1/2	16 1/2	23
General Mills	104 3/4	88 1/4	97 1/2
General Precision Equipment	42 1/2	31 1/2	38 1/2
General Railway Signal	39 1/4	33	37
General Tel. & Elec.	73 3/4	60	66 1/4
General Time	45	35	38 3/4
General Tire & Rubber	74 1/2	44 1/8	69 1/2
International Bus. Machines	589	494	589
International Tel. & Tel.	42 1/2	28	40
ITE Circuit Breaker	50 1/2	35 5/8	43-43½ (1)
Litton Industries	100 3/4	72 5/8	97 1/2
Lockheed Aircraft	93 3/4	86 5/8	88 1/8
Magnavox	63 3/4	48 1/4	54 3/4
Mallory	44 3/8	36 3/8	42 1/2
Minneapolis-Honeywell	128 1/4	111 1/2	125 3/4
Minnesota Mining & Mfg.	137 1/4	111 1/2	133 1/4
Motorola	91 3/4	57 1/2	84 1/4
National Acme	59 1/2	52 1/4	55 3/4
National Cash Register	80	66 1/4	70 1/4
Neptune Meter	39 5/8	32 3/4	36 1/2
North American Aviation	52 5/8	39 1/4	46 3/4
Northrop Aircraft	43 3/8	31 1/4	42 5/8
Otis Elevator	75 1/4	61 1/2	69 7/8
Philco Corp.	31 7/8	21	29 3/4
Radio Corp. of America	60 3/8	43 1/8	58 3/8
Raytheon Mfg.	70 1/8	56 1/2	66 1/4
Reliance Electric	53 1/4	42 5/8	52 3/4
Rheem Mfg.	24 1/8	18	20

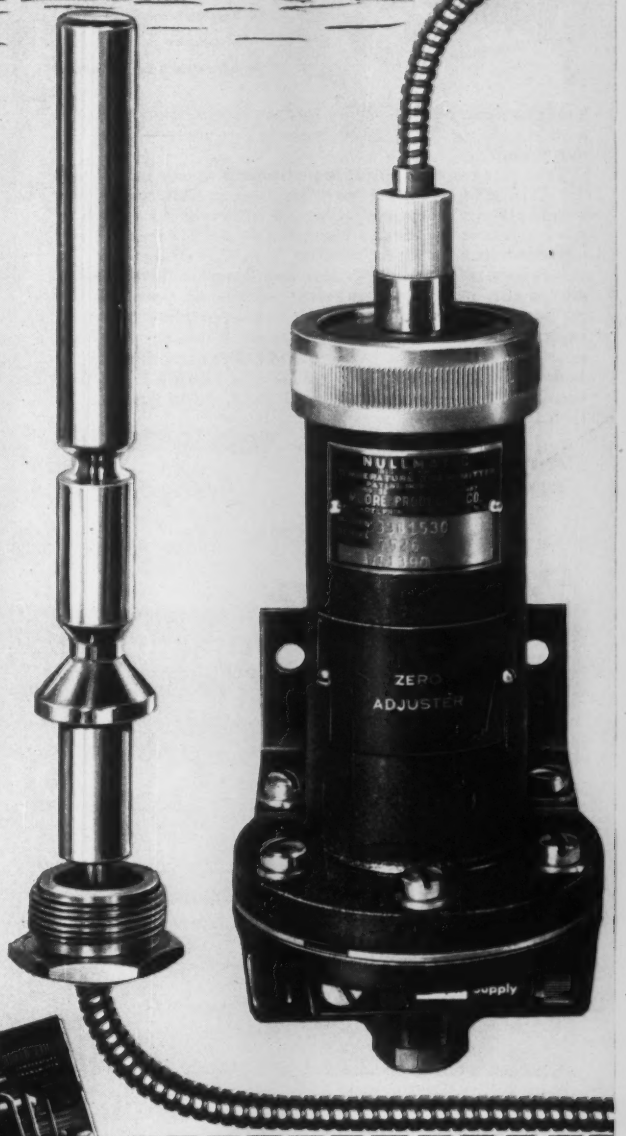
Continued on page 644

One Cubic Inch in 5000 Years!

If this thermometer were to leak its helium fill at the rate of only one standard cubic inch in 5000 years . . .
it would not pass our inspection!

Don't wait around to check it. *At the end of 100 years,* even the maximum leakage would result in a transmission error of less than ½ of 1%.

A mass-spectrometer-type inspection has been our standard production procedure since 1949. All elements are tested under pressure in an evacuated system which is capable of detecting helium leak rates as low as 7×10^{-11} scc/sec.



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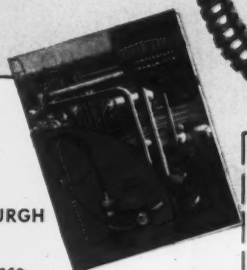
***are* FRICTIONLESS**

UNAFFECTED BY VIBRATION

LOW-COST

EASILY INSTALLED AND SERVICED



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Moore Products Co., Philadelphia 24, Pa.
Please send me the latest edition of Bulletin 3302 on NULLMATIC Thermometers.

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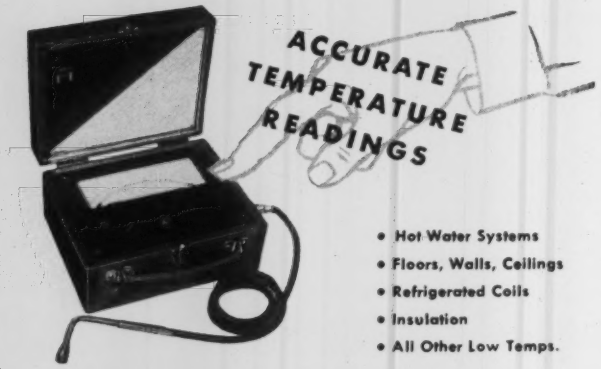

- Hot Water Systems
- Floors, Walls, Ceilings
- Refrigerated Coils
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You can accurately read any low surface temperature with the Alnor Type 2300 Surface Pyrometer—in 3 to 5 seconds.

Take this rugged, portable instrument to any job in the field and see how performance to laboratory standards can save invaluable time in balancing out a system...save the money lost on call-backs. Large 6" mirrored scale is direct reading, no conversion...no errors in readings...1° per division. Precision jeweled movement is protected against abuses of portable service by sturdy walnut case. Comes complete with matched thermocouple and lead ready to use on your next trip out. Send for Bulletin 4257. Tear out this ad and mail on your letterhead to: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle Street, Chicago 10, Illinois.

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

Alnor

For more information circle **29** on inquiry card.

New York Stock Exchange:

Continued from page 642

	HIGH	LOW	PRICE AS OF 4/14/59
Robertshaw-Fulton	45 1/4	31 5/8	42 1/2
Royal McBee	24 3/8	18 1/8	19 1/4
Sangamo Electric	49 1/4	35	48 3/8
Siegler Corp.	45 1/8	26 1/2	39 1/8
Sperry Rand	24 3/4	21 1/4	22 3/4
Square D	33 1/2	28 1/8	30 3/4
Standard Coil Products	21 3/4	14 3/8	17 3/4
Starrett (L.S)	72	65 3/4	71 1/2
Stewart-Warner	49 3/4	42 1/2	49 1/2
Telautograph	13 3/8	9	11 3/8
Texas Instruments	101 7/8	61 1/4	99 7/8
Thompson-Ramo-Wooldridge	68 3/4	56 1/4	61 7/8
Tung-Sol Electric	54 1/4	34 1/8	47
Underwood Corp.	30 7/8	20 5/8	26 7/8
Union Carbide Corp.	135	120 1/2	134 5/8
United Shoe Machinery	51 3/8	45 5/8	48 1/8
Western Union	39 3/8	29 3/4	37 7/8
Westinghouse Air Brake	38 1/2	32	36
Westinghouse Electric	81	70 1/2	79
Worthington Corp.	80 1/4	70 1/2	78

1) Not traded - Bid and Asked

Over-The-Counter

OVER-THE-COUNTER

	QUOTATION AS OF 4/14/59 BID	ASKED
Aerovox Corp.	7 1/2	8
Aircraft Radio Corp.	42	-
Argus Corp.	38 1/2	39 1/4
Black Sivalls & Bryson Inc.	24	25 1/4
Ritel McCullough	35 3/4	37
Electronics Associates	41 1/2	44
Electro Instruments	26	27 1/2
Erie Resistor Corp.	9	10
Fisher Governor Co.	17 1/4	17 7/8
Foxboro Company	53 1/2	55
G.M.Giannini	29 3/4	31 1/2
Industro Transistor	43/8	5
Liquidometer Corp.	8 1/2	9 1/4
W.L.Maxson	14 1/2	15 1/4
Penn Controls	21 1/2	23 1/2
Speer Carbon, Inc.	39	40 1/2
Sprague Electric	49 1/4	51 1/4
Taylor Instruments	34 1/2	35 1/2
Telecomputing Corp.	10 3/4	11 1/4
Topp Industries	13 1/8	14
Varian Associates	60	61
Vitro Corp. of America	14 3/4	15 1/4

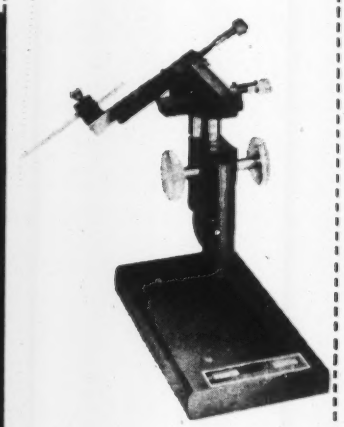
Brinkmann U.S.A.

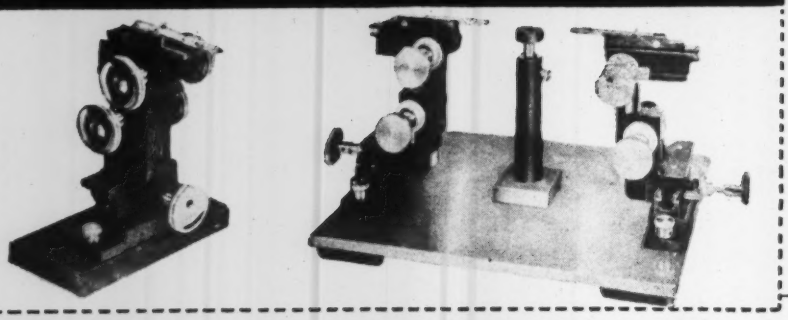
The most complete line of truly precision-built

MICRO MANIPULATORS

for scientific and industrial operations.

Brinkmann Micro Manipulators are available for use with stereoscopic and compound microscopes at magnifications from 10 to 1000 x. They can be used singly or paired. Many accessory items such as automatic pipette pullers, micro injection devices, pipette holders and microvises are available.





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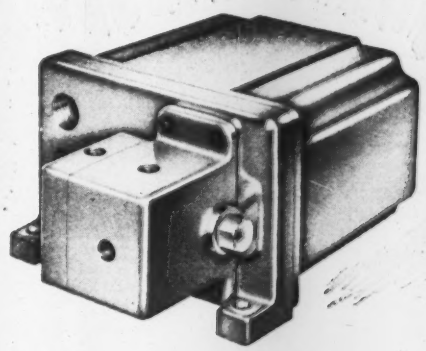
New from **GPE Controls...**

Model 776F **Flow Transmitter** has the lowest differential pressure requirement of any transmitter...as low as 3" w.c. for maximum output of 25 volts d.c. at power levels up to 5 watts. Permits use of larger orifices; transmission over as much as 5 miles; simultaneous operation of controllers, recorders, analog-to-digital converters. Automatically extracts square root for straight summarization of flows. Also Model 776D for differential pressure transmission.



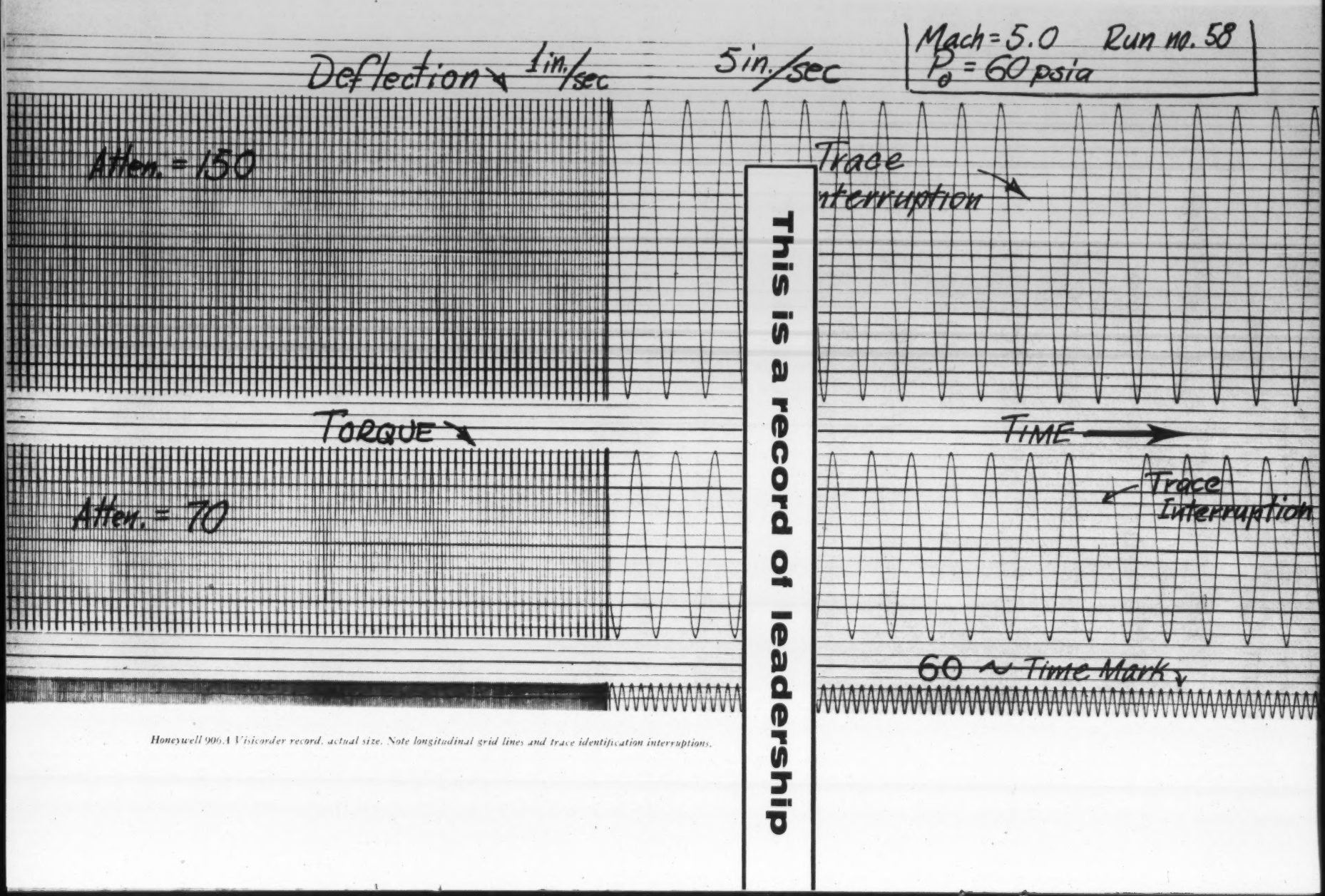
GPE Controls | A GENERAL PRECISION COMPANY

Write for descriptive literature

GPE Controls, Inc. (formerly Askania Regulator Company)
240 East Ontario Street • Chicago 11, Illinois

A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **31** on inquiry card.



This is a record of leadership

Honeywell 906A Visicorder record, actual size. Note longitudinal grid lines and trace identification interruptions.

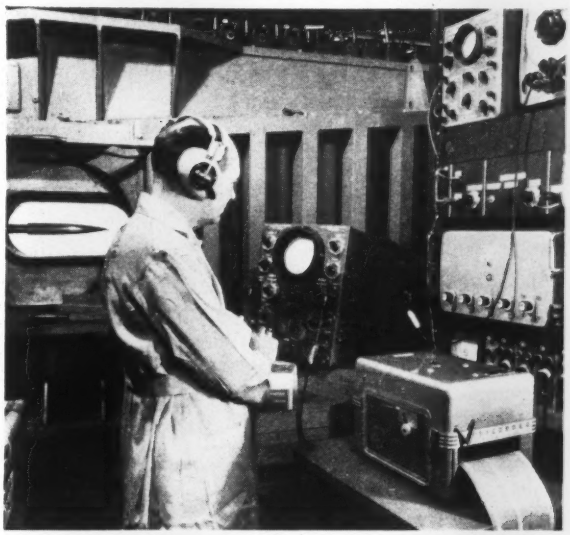
These studies of aerodynamic damping coefficients on an airframe were made by engineers at ARO, Inc. They were conducted in the Gas Dynamics Facility at the U.S.A.F.'s Arnold Engineering Development Center, Tullahoma, Tennessee, wind tunnel center of the Air Research and Development Command. The studies were directly recorded on a Honeywell 906-A Visicorder.

The problem: To measure damping-in-pitch derivatives for a clipped-delta-wing-body configuration over a Mach number range of 2.0 to 5.0 so that these measurements could be compared with the Mach number trend predicted by theory.

The set-up: A model of the delta-wing body, mounted on its cross-flexure pivot support, was forced to oscillate through a linkage by an electro-magnetic shaker. Resistance strain gauges were bonded to the input torque member and to one of the pivot supports. These gauges supplied torque and displacement signals through a carrier amplifier to two galvanometers in the Visicorder. An oscillator, driving a third galvanometer, established a time base for the oscillogram.

The values discovered through this forced-oscillation balance system experiment showed some discrepancies from values predicted by theory, because the theory pertained to simpler bodies than that used in the tests. The experiments provided a new set of data which will result in more accurate predictions for future design.

in aerodynamic research



Z. A. Woodard, Jr., ARO, Incorporated, instrument technician, operates the Visicorder in the measurement of aerodynamic damping coefficients.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new accessory units.

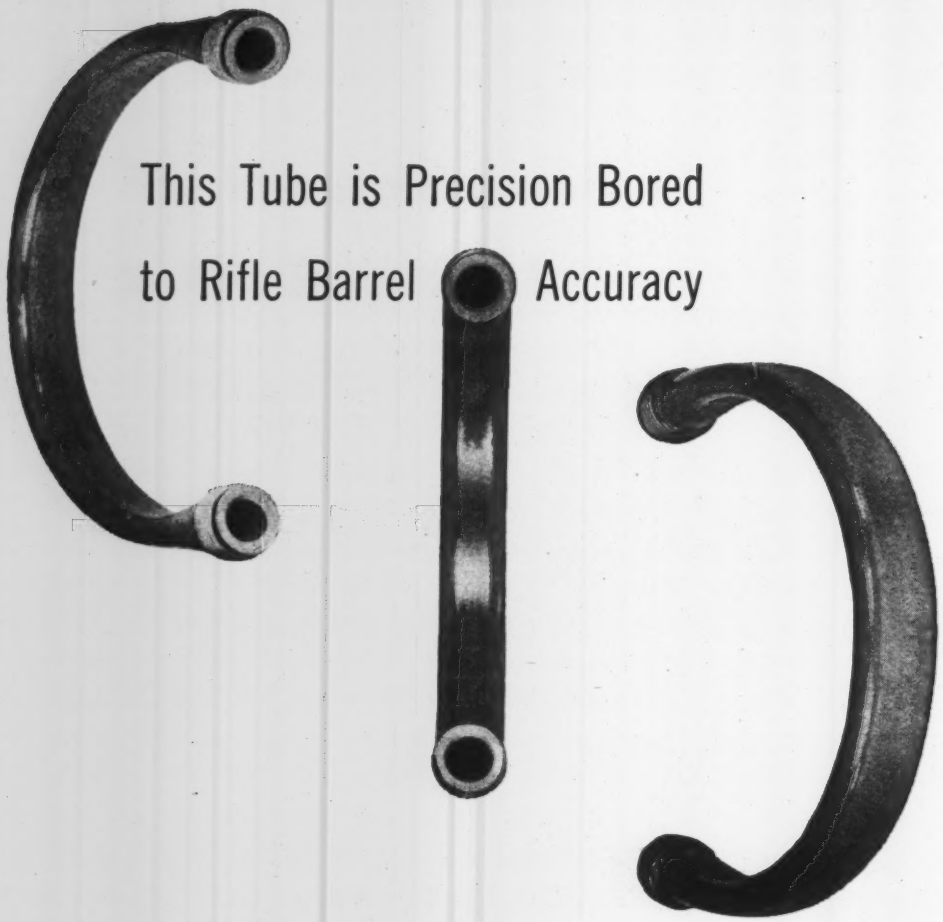
To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

Industrial Products Group

For more information circle 32 on inquiry card.



This Tube is Precision Bored to Rifle Barrel Accuracy

Ashcroft Duragauge in Phenol case — a tough, rigid plastic turret type case for wall or flush mounting.

The Bourdon tube in Ashcroft Duragauges is machined mirror-smooth inside and finish ground outside to exact tolerances. Strong, uniformly thick walls assure precise flexibility—sustained high accuracy and long life.

Eight tube materials permit you to select the best metal with sensitivity balanced by internal corrosion resistance. Whether your choice is phosphor bronze, an alloy steel, "K" Monel, a stainless steel or beryllium copper, metallurgical control is exact from ingot to finished tube. Socket and tip joints are welded or brazed, then stress relieved for highest strength and safety. "Whip testing" at pulsating pressures at least 50% greater than rated pressure insures calibration stability.

Order your Ashcroft Duragauges with the best Bourdon tube material for your service. Choose the all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. Full range of pressures, dial sizes, case designs and materials available. In any combination of components, Duragauges give sustained high accuracy and long service. Get details from your industrial supply distributor.

MANNING MAXWELL & MOORE TRADE MARK

G2-58

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

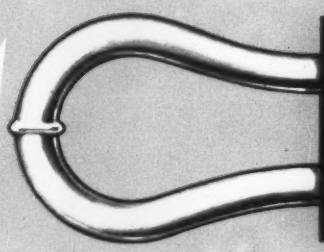
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **39** on inquiry card.

conax® Corporation

2316 WALDEN AVE.
BUFFALO 25, N. Y.

The Quality Line



conax®

- thermocouples
- pressure seals

For more information circle 1 on inquiry card.

conax® COMPLETE LINE of

conax Bare Wire Thermocouple Glands

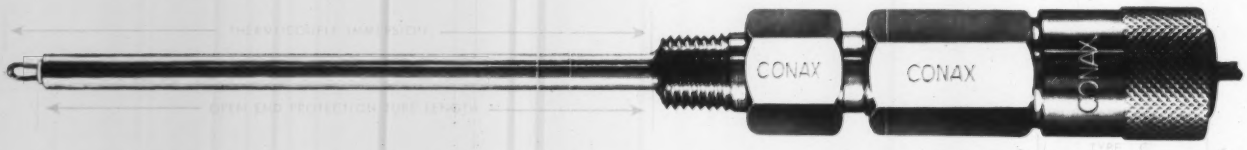
All Standard Models Are Type 303 Stainless Steel

TYPE A

Basic Type "A" Model in the wide range of Conax Stainless Steel Bare Wire Thermocouple Glands is normally used to seal two wires (from 24 gage to 8 gage) but may be supplied with special sealants and insulators to seal more than two wires. See cross section at bottom of opposite page.

TYPE B

Conax Type "B" Bare Wire Thermocouple Glands are same as Type A above except for the additional thread to receive conduit or thermocouple head.



TYPE C

Conax Type "C" Bare Wire Thermocouple Glands are the same as Type A above plus a convenient, compact method of terminating thermocouple wires and connecting cold end leads. Open end protection tubes, as shown, are available for Conax Type A, Type B and Type C Glands to prevent bending and breaking of wires when probing high velocity gases or viscous fluids.

See Pages 4-12 in Catalog 1885

conax Safetywells

Another Exclusive!

The only thermocouple probe providing the safety of a "DOUBLE BARRIER" plus fast response.

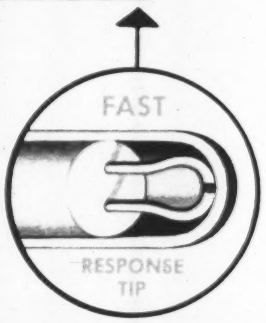
Conax Thermocouple Head (Model B-2)

Conax Safety Pressure Seal. (See cross section at bottom of next page)

Full protection in case of well rupture is provided by the Conax Safety Pressure Seal designed with Conax Stainless Steel Safetywells. This exclusive design permits light gage fast responding thermocouples to be used with greater safety than has been previously achieved with the heaviest "standard" wells. Fast response with resulting greater accuracy is insured by a butt welded thermocouple bottomed in a formed tip well. See photo at right.

Conax Safetywells completely seal in thermocouple elements eliminating oxidation and insuring the initial accuracy of small diameter thermocouples for the life of stainless steel well.

See page 13 in CATALOG 1885.



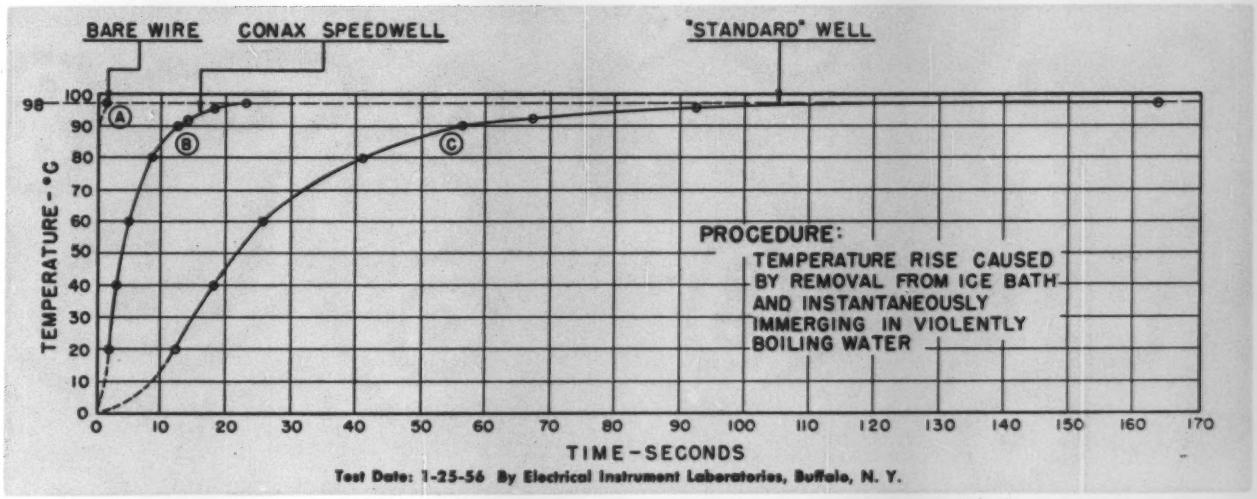
For more information circle 1 on inquiry card.

conax...The Quality Line

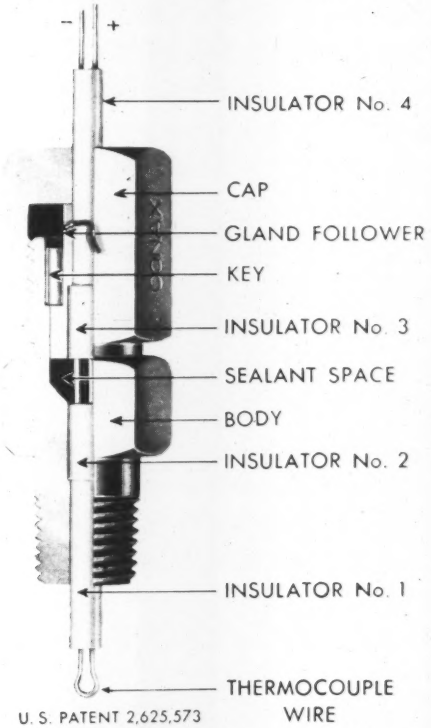
BARE WIRE THERMOCOUPLE GLANDS

Exclusive! THE ONLY SIMPLE, POSITIVE METHOD FOR SEALING TWO OR MORE BARE WIRES AT PRESSURES FROM .005 MICRONS TO 20,000 psi!...

LOWER MASS and FASTER RESPONSE



Test Date: 1-25-56 By Electrical Instrument Laboratories, Buffalo, N. Y.



U. S. PATENT 2,625,573

PROBLEM: To determine comparison response rates of bare wire thermocouples, Conax Speedwells and "standard" wells.

PROCEDURE: The same welded, 20 gage, copper-constantan thermocouple was used in the three tests to determine curves A, B and C in above chart. Both the Conax Speedwell and "standard" well were Type 304 stainless steel. "Standard" well was 7/16" O.D. x ¼" I.D. at the tip. Metallic contact was maintained between butt welded hot junction and well bottom in both tests to determine curves B and C. Removal from ice bath to complete immersion in violently boiling water took approximately ½ second for each test.

CONCLUSIONS: Bare wire thermocouples gave almost instantaneous response to temperature change. Conax Speedwells sense temperature change in only 23 seconds. Lag of "standard" wells is 1 minute and 43 seconds greater than bare wire thermocouples.

REFERENCES: Conax Bare Wire Thermocouple Glands pages 4 - 12. Conax Speedwells pages 14 and 15 and also Conax Quick Disconnect (Speedwells) pages 16 and 17 in CATALOG 1885.

Principle of Sealing Conax Thermocouple Glands

The sealant in a Conax Bare Wire Thermocouple Gland (see Type A, Type B and Type C top left page) is compressed between two porcelain insulators under a pressure of 50,000 to 100,000 psi. This is made possible by the high degree of confinement of the sealant. When preformed Neoprene or Lava are used, this high pressure, forcing the sealant against the wire, makes it possible to seal pressures as high as 20,000 psi. Actual compression of the sealant is attained in this manner: (a) "Insulator No. 2" is retained in the "Body" by a supporting shoulder; (b) the sealant is placed in the "Body" cavity above "Insulator No. 2"; and (c) it is compressed when the "Gland Follower" containing "Insulator No. 3" is forced down by tightening the "Cap". The "Key" prevents the "Gland Follower" from turning and causing the wires to twist during assembly. Special care has been taken in designing the keyway to allow some freedom of rotary motion in the Gland Follower. This permits easy disassembly of the units for changing the wires.

For more information circle 1 on inquiry card.

conax® COMPLETE LINE of

conax Speedwells

EXPLODED VIEW

ASSEMBLED

Hot junction of light gage insulated thermocouple is securely bottomed in the tip of closed well. Thermocouple element has longer life because it is sealed inside the Conax Stainless Steel Speedwell and cannot be corroded by toxic gases that are normally free to flow into the well with each temperature change. This "breathing" is prevented by the Speedwell Gland.

Complete immersion adjustment is provided by Conax Midlock Fitting or Conax Midget Packing Gland.

See pages 14 and 15 in CATALOG 1885.

conax Quick-Disconnect Thermocouples

Simply plugging the polarized jacks together and turning nut finger tight complete the water-proof, vapor-proof connection. Accuracy of the Conax "QD" is insured by using thermocouple material in plugs and sockets.

Light gage thermocouple wires for fast response are bottomed in small diameter, low mass stainless steel protection tubes. This versatile Quick-Disconnect may be used with Conax Con-O-Clads.

See page 16 and 17 in CATALOG 1885.

conax Thermocouple Heads

Compact lightweight Conax Thermocouple Head has chrome finish for corrosion resistance. Available in two or four post models and accommodates 30 gage to 14 gage wire. Waterproof model has O-ring and grommet drilled to fit lead wire.

Easy to assemble — screws loosen, do not remove. Often used with Conax Thermocouple Glands.

See page 23 in CATALOG 1885.

conax Adjustable Pipe Clamp Thermocouples

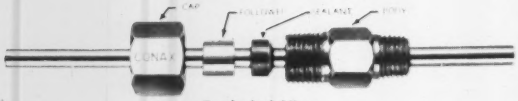
For accurately reading outside pipe temperatures, Conax Adjustable Pipe Clamp Thermocouples are installed in less than a minute on alloy, plastic or glass pipes for checking effectiveness of insulation and other temperature measuring devices.

Ideal for use wherever immersion thermocouples are impractical or undesirable or where extreme corrosion and erosion are problems. Available with Copper-Constantan, Iron-Constantan, and Chromel-Alumel* thermocouple.

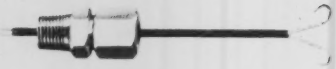
See page 21 in CATALOG 1885.

*TRADE NAME OF HOSKINS MFG. CO.

conax Stainless Steel Packing Glands

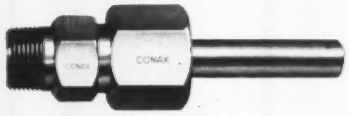


Exploded View



✓ SEALS WIRES

✓ SEALS WELLS



✓ SEALS TUBES

Conax Stainless Steel Packing Glands are easy to assemble just (1) Slide in wire or tube and (2) tighten cap. Tubes are not damaged in sealing due to the use of "soft" sealants which permit sealing glass, ceramic, stainless steel, aluminum or brass tubes from 1/16" to 3/4" diameters with temperature range from —300°F. to +1850°F. and pressures up to 10,000 psi. Ideal for use with Conax Con-O-Clads. See pages 26 and 27 in CATALOG 1885.

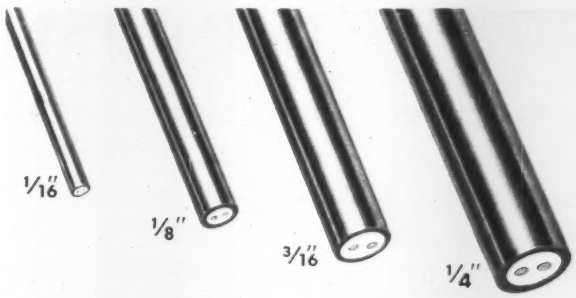
For more information circle 1 on inquiry card.

conax...The Quality Line

THERMOCOUPLE ASSEMBLIES

conax® *con-O-clad®*

mineral insulated thermocouples



CON-O-CLAD Mineral Insulated Thermocouples are made by Conax under specially and exclusively developed processes that insure quality . . . Conax quality. Manufacturing procedures guarantee finished thermocouples that are unmatched for excellence.

CLEANLINESS — Controlled environmental conditions, dust free work areas and clinical approach at Conax insure high purity. All sheathing surfaces are chemically cleaned to eliminate any insulation contamination.

INSULATION — Highest purity magnesium oxide is standard insulation. Other inert oxides available for special applications.

HOT JUNCTIONS — Electrically butt welded and annealed hot junctions by Conax insure long life with maximum accuracy.

SWAGING — A process highly refined by Conax, compacts oxides in CON-O-CLAD close tolerance sheathing without distortion or embedment of thermocouple wires.

WELDING — Inert gas arc welding hermetically seals tips which have been formed by cold swaging. No dangerous fluxes are used, insuring longer life and greater accuracy.

conax *con-O-clad* HOT JUNCTIONS

Type "G"

Hot junction is homogeneously welded to tip forming pressure tight closure. This small mass protective tip is integral with hot junction producing almost instantaneous response rate.

Type "U"

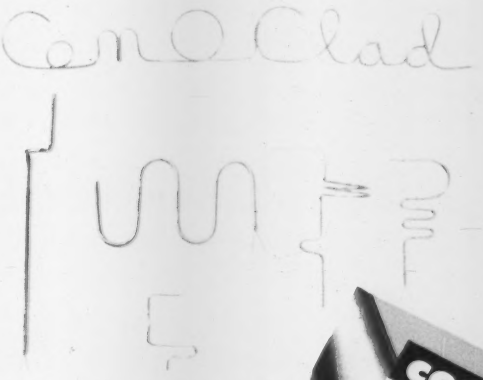
This ungrounded hot junction is tightly packed in mineral oxide preventing failure by vibration or other physical damage including the "hammer test".

Type "B"

Electrically butt welded hot junction insures minimum mass and maximum rate of response. Insulation is pressure sealed against moisture penetration.

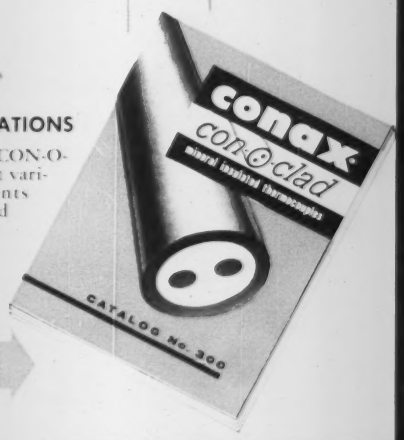
Type "L"

This unique type consists of hot junction with single embedded thermocouple wire through each leg of sheath. Available only in .0625" O.D. this type, with small mass has rapid response rate equal to No. 14 gage bare wire thermocouple.



UNLIMITED CONFIGURATIONS

Typical of unlimited Conax CON-O-CLAD configurations to meet various installation requirements without damage to sheath and wire or loss of electrical resistance.



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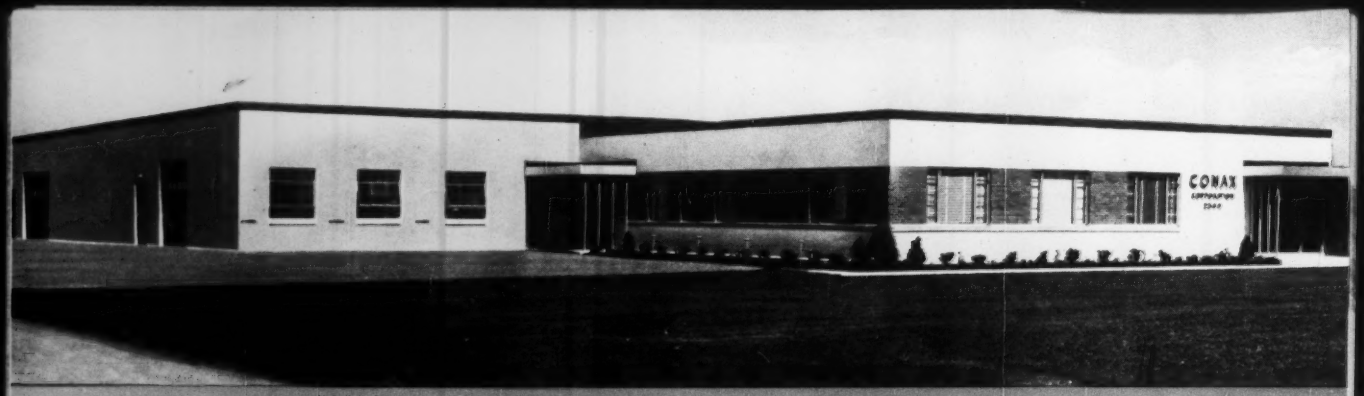

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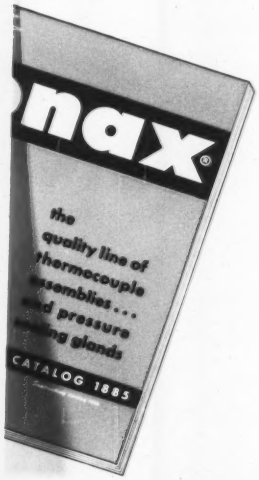

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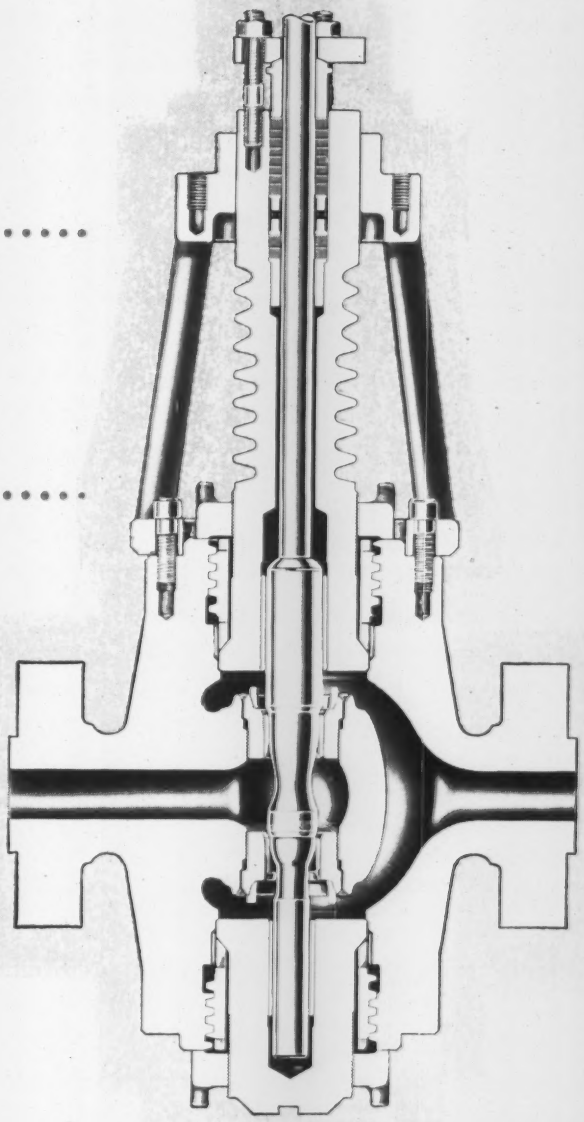

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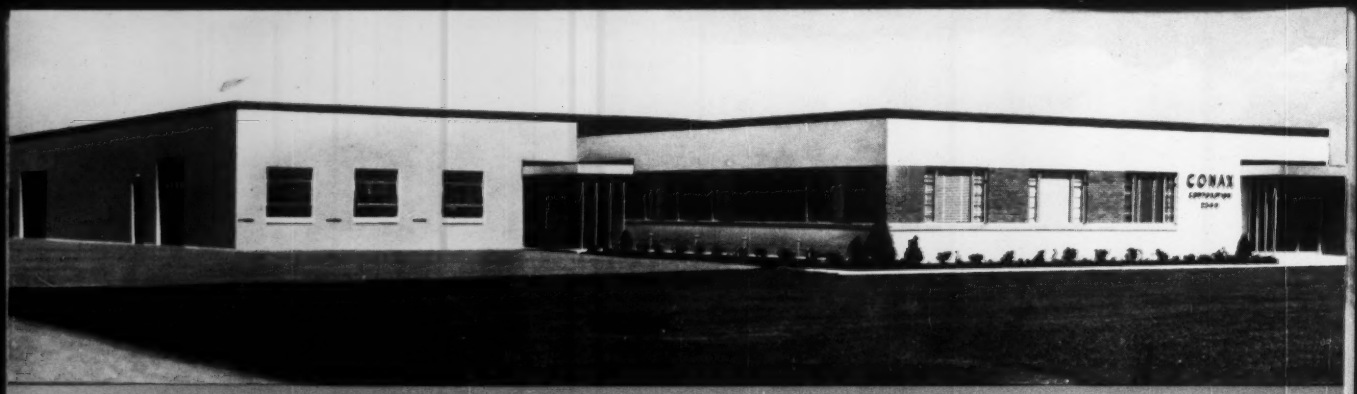

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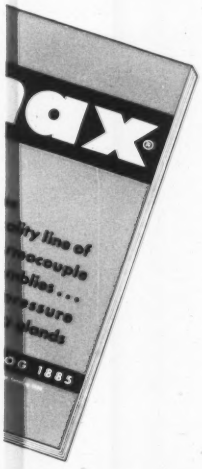

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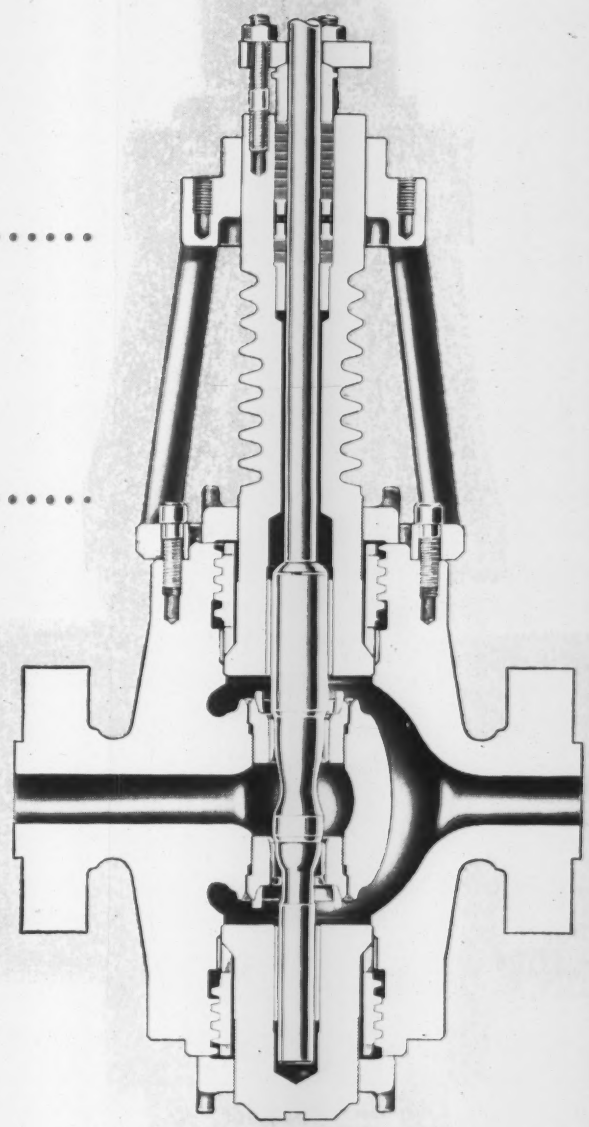

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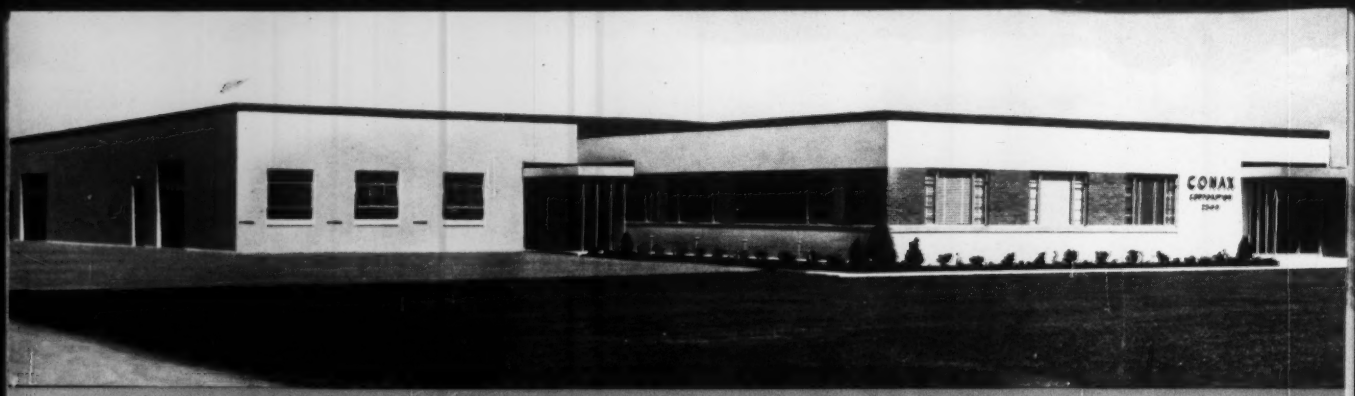

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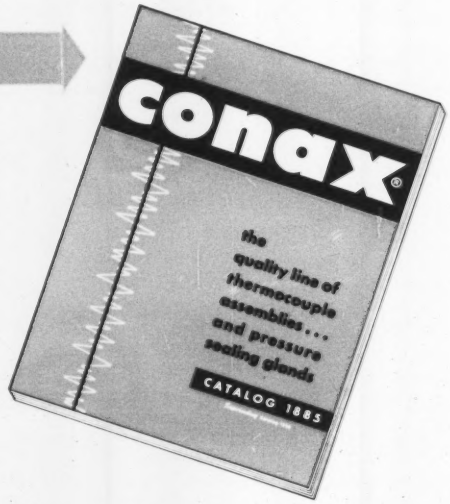

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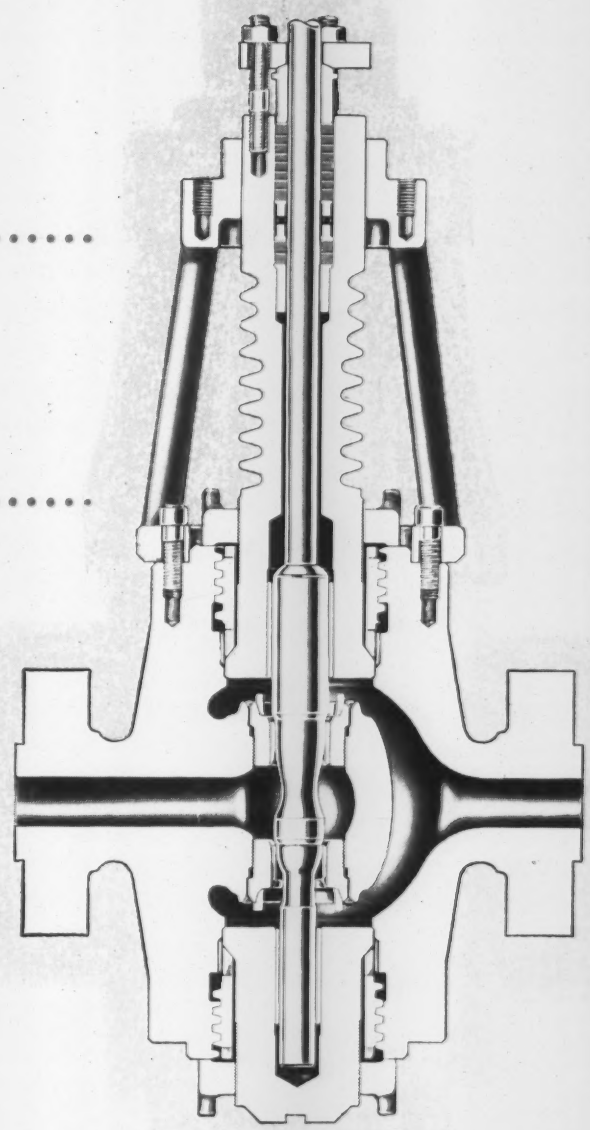

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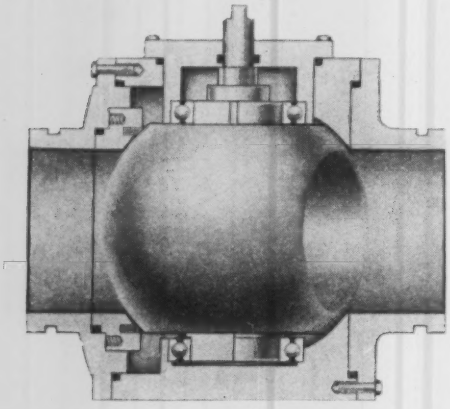
Ball Valves

Flo Ball Valves offer all these advanced design features:

(1) 100% flow efficiency—Hydromatics' exclusive Flo-Ball design provides a straight-thru unrestricted fluid path, exactly equal to the pipe line diameter . . . (2) Perfect sealing—zero leakage is assured through the use of a precision ball—the ideal geometric form for perfect sealing contact . . . (3) Low operating



torque—ball rotates in precision bearings which absorb all pressure loads. Pressure balanced valve seat further minimizes forces on ball, reducing friction drag . . . (4) Long life . . . (5) High speed action—only 90-degree rotation is required to fully open or close valve. Full travel as fast as 5 milliseconds . . . (6) Cryogenic and corrosive applications . . . (7) Modular arrangement . . . (8) Versatility . . . (9) Reliability.—(*From new 28-page binder which includes Company's facilities, Hydromatics, Inc., Livingston, N. J.*)

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Thermowell is Safe and Fast

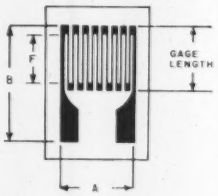
"Safetywell" combines safety and fast response for the first time . . . Full protection in case of well

rupture is provided by a positive pressure seal designed into the Conax Safetywell—(*From new 36-page Catalog 1885, Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.*)

For this literature circle **195** on inquiry card.

Etched-Foil Strain Gages

Foil gages exhibit a number of desirable physical and electrical characteristics:—high longitudinal strain sensitivity (5% to 8% higher than equivalent wire gages); accurate measurement may be made up to 1½% elongation; low transverse strain sensitivity (desirable in resolution of biaxial strains); high fa-



tigue life; negligible hysteresis; fatigue resistance is generally higher than that of equivalent wire gages; improved handling and application characteristics . . .

SR-4 Foil Gage grids are produced by a precision photo-etching process from extremely thin sheets of Constantan or Nichrome V foil. Backing material used is phenolic (Bakelite), nitrocellulose (impregnated-paper), or epoxy. The Bakelite type gage is only .003" thick; the paper type, .006" thick; three-element rosettes, .006" thick.

Strippable-back gages are available for high-temperature application, and extended-end-tab types provide extra ease in handling and application.—(*From new 24-page Specifications and Price List 4310 "SR-4 Strain Gage", Baldwin-Lima-Hamilton, Electronics & Instrumentation Div., Waltham 54, Mass.*)

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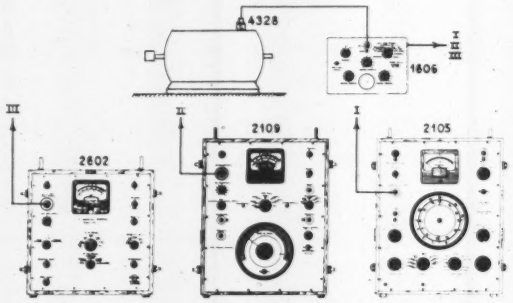
Accelerometers

An Accelerometer is a mechanical-electrical transducer, the electrical output of which is proportional to the magnitude of the acceleration to which the transducer is subjected.



Different transducing elements such as piezo-electric crystals or electrically polarized ceramics may be used to obtain this performance . . . An example of the latter type of transducing elements is Barium Titanate.

When vibration measurements are carried out the frequency response of the complete measuring arrangement must be considered as shown.—(*From new 24-page Booklet 4308 • 4309, B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.*)

For this literature circle **197** on inquiry card.

versatile unit in Foxboro's exclusive 100% solid-state electronic control system

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For more information circle **35** on inquiry card.

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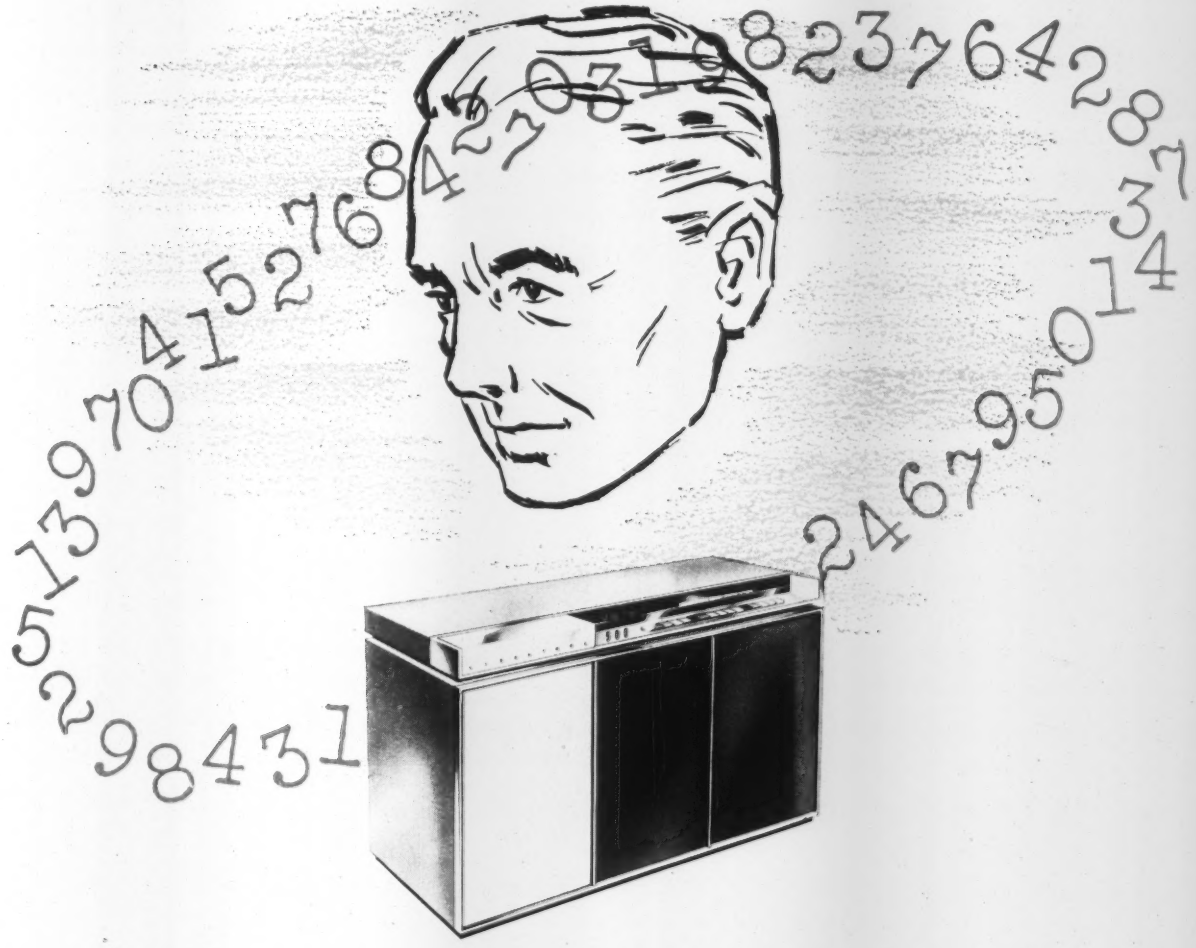

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For more information circle **37** on inquiry card.

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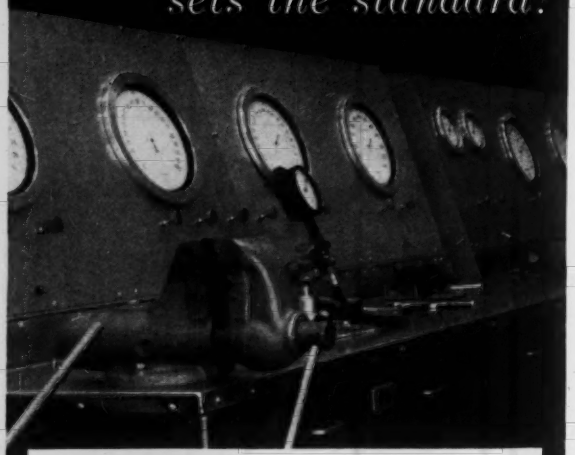

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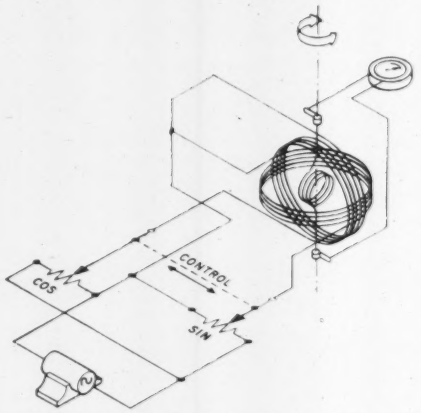
For more information circle **38** on inquiry card.

The Inductosyn Principle

The basic principle is well illustrated by the electromagnetic goniometer . . . It consists of two stationary crossed coils and a third coil mounted on a rotating shaft. If two of these devices are paired and their stationary (stator) coils connected together as shown . . . they may be used as transmitter and receiver of angular data. If an a-c voltage is applied to the rotary coil (rotor) of the transmitter, a voltage maximum will



appear at the rotary coil of the receiver when the two rotors are at the same angle with respect to their associated stators, and a voltage null will occur at $\pm 90°$ from this position. As the rotor of the transmitter is turned, the induced voltage in one stator coil follows a sine curve and the voltage induced in the other follows a cosine curve . . .

Figure shows how one of these devices can be used to reproduce an ankle in response to an input of analog voltages representing the sine and cosine of the required angle. When the output voltage of the receiver rotor is at a null, its angular position corresponds to the complement of the angle whose sine and cosine are developed in the control.—(*From new 32-page Booklet ER*312, *Sup.* 1, *Farrand Controls, Inc.*, 4401 *Bronx Blvd., New York* 70, *N. Y.*)

For this literature circle **198** on inquiry card.

Custom Control Systems

Today, modern and progressive purchasing and engineering departments are keenly aware of the importance of the "systematic approach." When controls are required they consult an instrument manufacturer. When special engineering assistance is required they contact an established consulting engineering firm.—And when a coordinated control system is required they logically want to deal with a firm that is specifically organized and equipped for this type of manufacture—in short, a control panel specialist.

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For this literature circle **199** on inquiry card.

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For more information circle **33** on inquiry card.

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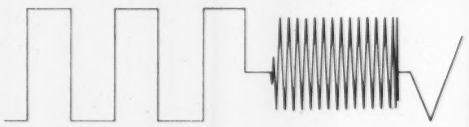
For more information circle **40** on inquiry card.

New Recording Concepts

With billions of dollars now being devoted to research and development, the role of electronic data gathering and recording equipment as an engineering tool has assumed new importance. From the simple metering device to the complex analog and digital computer, a broad range of instrumentation is now available to industry, commerce and the applied sciences . . .



The direct writing Recorder alone possesses all of these important advantages: instant readout; accuracy and resolution; wide application versatility; high reliability and stability; analog presentation vs. time; permanent and reproducible charts; simple operation; essential ruggedness; low operating costs . . .

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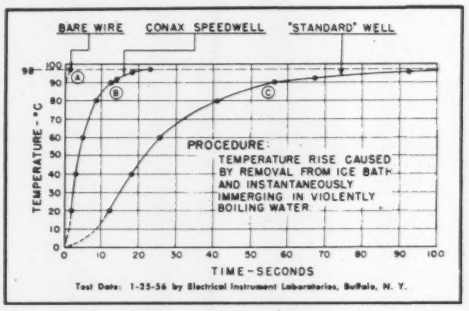
For this literature circle **200** on inquiry card.

Response of TC Glands

Problem: To determine comparison response rates of bare wire thermocouples, Conax Speedwells and "standard" wells . . . Procedure: The same welded, 20 gage, copper-constantan thermocouple was used in the three tests to determine curves A, B and C in chart. Both the Conax Speedwell and "standard" well were Type 304 stainless steel. "Standard" well was 7/16"



O. D. x 1/4" I. D. at the tip. Metallic contact was maintained between butt welded hot junction and well bottom in both tests to determine curves B and C. Removal from ice bath to complete immersion in violently boiling water took approximately ½ second for each test.

Conclusions: Bare wire thermocouples gave almost instantaneous response to temperature change. Conax Speedwells sense temperature change in only 23 seconds. Lag of "standard" wells is 1 minute and 43 seconds greater than bare wire thermocouples.—(*From new* 36*-page Catalog* 1885, *Conax Corp.*, 2300 *Walden Ave., Buffalo* 25, *N. Y.*)

For this literature circle **201** on inquiry card.

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GASCLOK
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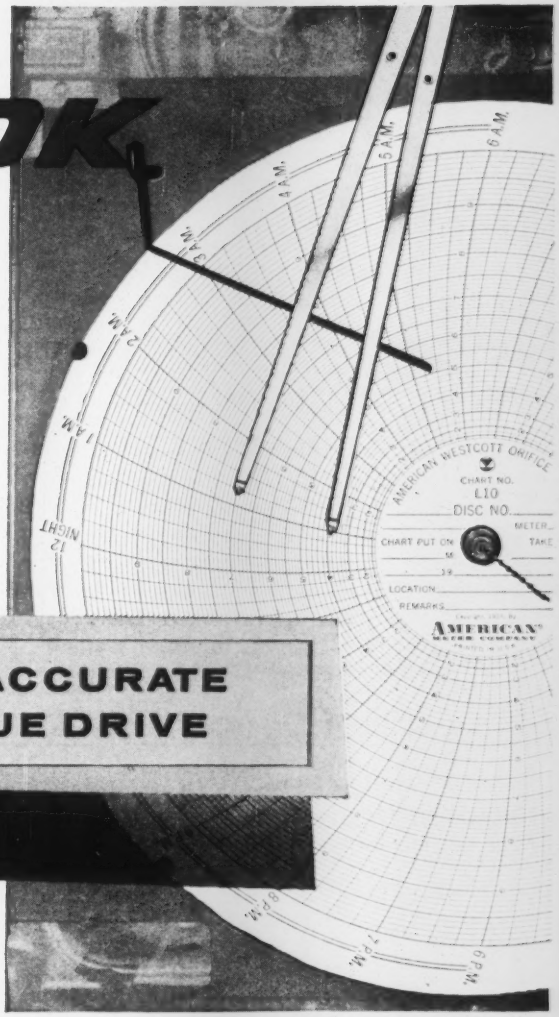

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For more information circle **41** on inquiry card.

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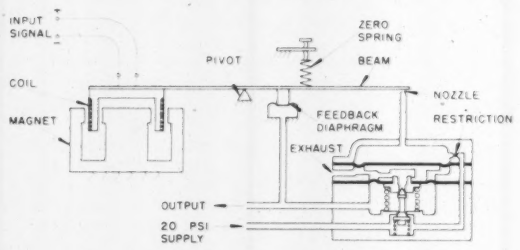
BOEING

For more information circle **42** on inquiry card.

Electro-Pneumatic Transducer

An increase in the dc ma signal to the coil of the force motor raises it and causes the beam to move closer to the nozzle. The resulting restriction at the nozzle produces an increase in nozzle pressure and in the upper chamber of the relay. The relay diaphragm assembly will move down, opening the inner valves to

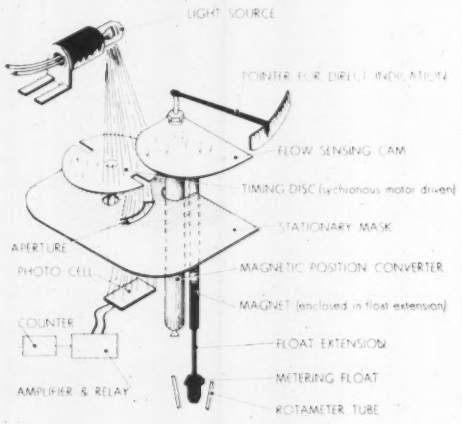


the supply pressure. Air as the operating medium flows into the central chamber of the relay, increasing the output pressure until the relay diaphragm assembly is pushed back to its original position and the inner valve is closed again. The increased output from the relay goes to the control valve and also to the feedback diaphragm. The force of the pressure on the feedback diaphragm acts on the beam. In this way, the new relay output pressure is compared to the input current by the force balance principle. When a balance of the two forces exists, the relay output pressure is exactly proportional to the input current.—(*From new 4-page Bulletin E-60, Fisher Governor Co., Marshalltown, Iowa.*)

For this literature circle **202** on inquiry card.

Flow Integrator

The MPT-53 integrator, for automatic batching applications and for billing or record purposes, consists of a synchronous, motor-driven digital counter which is actuated by energy from a photo cell. A light source

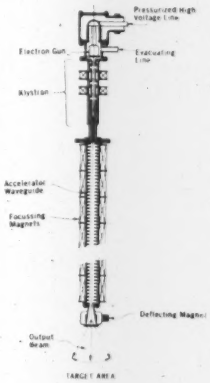


provides excitation to the cell. The duration of photo cells' exposure to the light is determined by a timing disc and a characterized flow sensing cam.—(*From new 12-page Bulletin 170, Brooks Rotameter Co., Lansdale, Penna.*)

For this literature circle **203** on inquiry card.

Linear Accelerator

The Mark 1-F4 linear electron accelerator is designed as a highly versatile source of high energy electrons, X-rays and neutrons for research, pilot studies, and limited commercial processing . . .

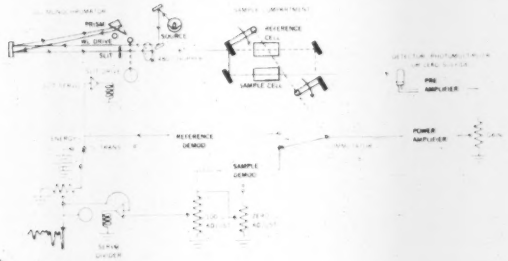


By stopping the electron beam in a heavy metal target, an intense X-ray beam is generated. X-ray intensity at any point in the field varies with distance from the converting target, the distance from the center axis of the beam and the beam scan. If the electron beam is spread over the X-ray target, the resulting X-ray field resembles the electron field.—*(From new 8-page Bulletin 1002, Applied Radiation Corp., Walnut Creek, Calif.)*

For this literature circle **204** on inquiry card.

Ratio-Recording Spectrophotometers

Light from the source (Tungsten or Hydrogen Lamp) is chopped at 480 cycles per second (eliminating DC drift when the light beam ultimately is converted to an AC signal for amplification), and reflected into the monochromator. The 30° crystal quartz prism disperses the light beam twice, providing high resolution over the entire wavelength range. Monochromatic light is focused by a simple lens onto a 15 cps rotating mirror and, alternately directed through



the sample and the reference (double-beam sample system). Light transmissed by the sample and reference impinges on a single detector (1P28 Multiplier Phototube or PbS Cell). The signal from the detector (now an a-c voltage) is amplified, and transferred to the demodulators; . . . this double-beam ratio principle minimizes the effects of changes in source and supply voltages, tube characteristics, and detector response.

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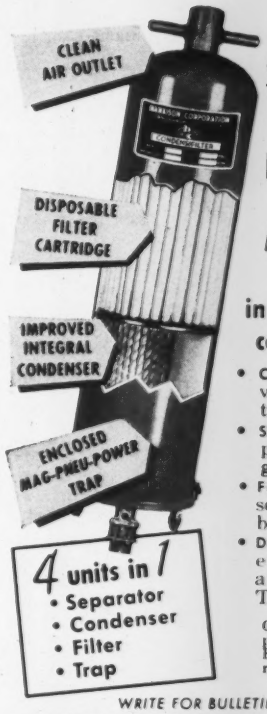
For this literature circle **205** on inquiry card.



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Heat Inertia Problems of Automatic Control of Temperature

by Victor Broida . . . "fictitious mass" concept of heating process unit under automatic control. Paper, 61 pages, 1950. **$1.00**

The Electronic Control Handbook

by Batcher and Moulic . . . presents electrical and electronic principles applicable to measurement and automatic control. Paper, 244 pages, illustrated, 1946. **$2.00**

Strain Gage Instrumentation

edited by Aronson and Nelson. ". . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages." Paper, 110 pages, illustrated, indexed by company, author, and subject, 1958. **$2.00**

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—Modern Theory and Their Usefulness. Includes 90 advanced papers on control technology as delivered in original language (about ½ of book is in English). Cloth, 9 x 12", 508 pages, 1957. **$25.00**

Digital Techniques for Computation and Control

by Klein, Morgan and Aronson . . . all basic digital techniques within one text . . . code arithmetic, logical networks, multiplexing, conversion, data reduction, digital process control, two-terminal relay circuits, counting techniques, digital computers, programming, digital differential analyzers, and combined analog-digital equipments. Cloth, 394 pages, illustrated, 1958. **$6.00**

INSTRUMENTS PUBLISHING CO.

845 Ridge Ave., Pittsburgh 12, Pa.

NC NORWOOD CONTROLS

PRESSURE TRANSDUCERS

BONDED STRAIN GAGE RUGGEDNESS

No damage at 1,000 g to 2,000 cps . . . no unsupported fine wires to resonate or fracture.

2 in 1 — *BOTH* static *AND* dynamic measurements with *ONE* transducer . . . for use with any read-out equipment from standard strip-chart recorders to cathode ray oscilloscopes.

PLUS — 4 arm 350 ohm strain gage bridge . . . high dynamic response: natural frequency 50 KC; damping constant .2 (cooled) . . . only ¼ of 1% maximum zero shift when flame of acetylene torch passes rapidly over diaphragm . . . all welded diaphragm for corrosive applications . . . ranges: 0-25 to 0-60,000 psi.

WRITE for data sheets covering Norwood Controls Transducers, Norwood Controls Unit, Detroit Controls Division, 937 Washington Street, Norwood, Massachusetts.

AMERICAN-Standard PRODUCTS

AMERICAN-Standard

DETROIT CONTROLS DIVISION

For more information circle **45** on inquiry card.

TO UPGRADE INSTRUMENTATION . . .

Kollsman specified Cobehn spray-clean equipment

To critically clean precision instrument bearings for assembly in navigational instrumentation, Kollsman Instrument Corporation, Syosset, N.Y., specified Cobehn automatic parts cleaner. The unit installed *(illustrated in operation above)* automatically, safely and economically removes bearing contaminants; critically cleans 2400 bearing components an hour, unit cost is approximately 3 mils.

Cobehn precision parts cleaners are engineered to critically clean semi-conductors, gear clusters, bearings, switches, relays and other small electronic and electromechanical components on a continuous production schedule. Oil, grease, silicone lubricants, rosin flux and other foreign matter are safely and economically removed in seconds.

The Cobehn cleaning method provides:

a) Uniformity in cleaning technique;
b) Close control over solvent costs;
c) Controlled rotation of parts during cleaning;
d) Elimination of chilling and condensation;
e) Chemically cleaned parts without film, residue or corrosive effect. (Fractionally distilled Cobehn solvent far exceeds Fed. Specification P-S-661 b);
f) Integral ventilation system.

Cobehn Portable Parts Cleaner
Model No. 1-2BC-2S-2

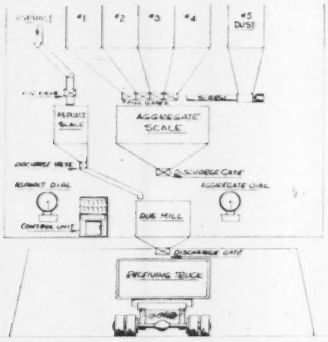
For specific information about your critical cleaning problems, send product information and production requirements. Our engineering report will be forwarded without delay.

Cobehn®Inc.
226 Passaic Avenue
Caldwell, New Jersey

For more information circle **46** on inquiry card.

Automatic Asphalt Batching Control

Batchmaster Model BMA-2SM is an automatic weight proportioning control unit designed especially for asphalt plants. The system consists of an integrated

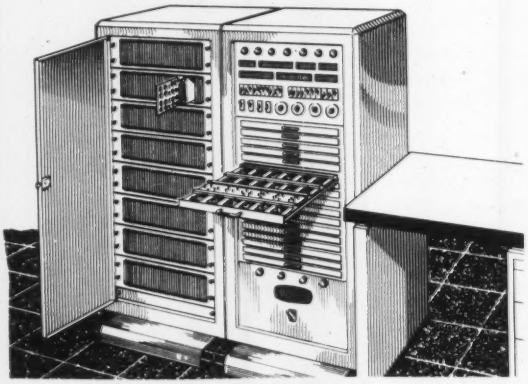


two scale control. BMA-2SM allows pre-selected direct dialing (in pounds) of the individual ingredient weights required for various formulas. After the initial "setting-up," the operator simply selects the desired formula and pushes the start button. Batchmaster then automatically controls the selection, feeding, weighing, mixing and discharge of all ingredients. —(*From new 6-page Sales Data Bulletin EP-SD-7, Howe Scale Co., Rutland, Vt.*)

For this literature circle **206** on inquiry card.

Process Control Computer

A new digital computer, recently included in the Ferranti range, designed for the control of a variety of industrial processes such as occur in power stations or chemical plants . . .



The 16 trays provide for 512 program instructions in the basic computer, but for those control applications where this is insufficient a third cabinet containing further trays can be added to give a maximum of 4096 instructions. In the special tray mentioned above, 128 constants can be pegged up and in addition, ferrite cores provide storage for 256 words of data.—(*From new 5-page Bulletin W112, Ferranti Electric, Inc., 95 Madison Ave., Hempstead, L. I., N. Y.*)

For this literature circle **207** on inquiry card.

BREAKTHROUGH

in oxygen measurement!

Now you can measure oxygen concentration simply, quickly, accurately with this new direct meter reading instrument from MSA.

The M-S-A® Portable Oxygen Indicator puts the finger on oxygen deficiency and hazardous oxygen leakage. In purging gas transmission lines or process systems of air, this precision instrument can be used to determine rate of progress.

You can also use it to do a number of other jobs that could never be done in the past. Take spot checks of inert atmospheres. Solve problems of combustion control. Measure oxygen content of flue gases. Guide the proper proportion of fuel and air.

The M-S-A Portable Oxygen Indicator measures oxygen in *gaseous mixtures* at location of sampling line inlet, at time of tests. Simplicity of design makes it easy to operate, convenient to use, and a snap to service. Large meter scale can be read at a glance. 0.5% accuracy.

An accessory liquid trap guards against condensation of water vapor from high temperature samples. An accessory scrubber containing chemisorbent is available to guard against strongly acid gases. Entire instrument is housed in rugged aluminum case only 6¾" x 4⅛" by 5¾" high. Sampling lines of various lengths are available. Weighs only 5¾ lbs.

The versatility of such an instrument could add a big boost to the efficiency of your operation. Another consideration is the extra margin of safety it provides for work crews. Ask the MSA Representative for a demonstration, and write MSA for a descriptive bulletin.

MSA®

MINE SAFETY APPLIANCES COMPANY
201 N. Braddock Avenue, Pittsburgh 8, Pennsylvania

MINE SAFETY APPLIANCES CO. OF CANADA, LTD.
500 MacPherson Ave., Toronto 4, Ontario

82 Branch Offices in the United States and Canada

For more information circle **47** on inquiry card.

DIGITAL OHMMETER — for rapid, precise resistance measurement

With Cubic
THE DIFFERENCE IS IN THE QUALITY

Cubic's rigid quality control standards, years-ahead design, and careful attention to construction detail are combined to produce *the superior* resistance measuring instrument.

THE NEW CUBIC DIGITAL OHMMETER offers automatic range selection, four and five digit display, wide range capability, and high accuracy on all ranges (mid-range accuracy: .01% and one digit). Four input leads (two current leads and two voltage leads) eliminate the effect of lead and contact resistance. An AC rejection filter prevents induced hum pickup. Special bridge design and highly sensitive null detector give meter readings with a minimum of current applied to resistance under test. In the Cubic Ohmmeter the addition of a resistor in the digital bridge permits calibration against standards up to 10% over full scale (1.0999). Precision resistors and quality components assure excellent stability — drift is .003% per year maximum. Cubic's unique "controlled drive" stepping switch turns off the drive circuit part way through the switch cycle, and the switch "coasts" to a stop, reducing mechanical impact and preventing overdrive.

CUBIC DIGITAL SYSTEMS can be developed easily to fit any requirement — with unit construction, featuring inter-*case* wiring and standard-size plug-in units. Every Cubic system is "customized" through standard construction. Cases provide rear and front-panel connections for input. Outputs are provided for printers or remote indicators. Other Cubic instruments — AC Converters, Voltmeters, Scanners, Pre-Amplifiers, Printer Control Units and Ratiometers — can be combined as "building blocks" to produce digital systems of "Cubic-customized" versatility. The Cubic Digital Ohmmeter is easily incorporated into a "system that designs itself."

SPECIFICATIONS

Display: 4 or 5 digits, decimal point, Ω, KΩ, MΩ, and "over-range" symbols.
Meter Ranges, Model 0-41, Four Digits:

Range		Accuracy	Max Test Current
00.00Ω	to 99.99Ω	± 0.02% & two digits	13ma
100.0Ω	to 999.9Ω	± 0.01% & one digit	1.3ma
1.000KΩ	to 9.999KΩ	± 0.01% & one digit	130μa
10.00KΩ	to 99.99KΩ	± 0.01% & one digit	13μa
100.0KΩ	to 999.9KΩ	± 0.03% & two digits	1.3μa
1.000MΩ	to 9.999MΩ	± 0.03% & five digits	1.3μa

Meter Ranges, Model 0-51, Five Digits:

Range		Accuracy	Max Test Current
000.00Ω	to 999.99Ω	± 0.01% & two digits	10ma
1000.0Ω	to 9999.9Ω	± 0.01% & one digit	1ma
10.000KΩ	to 99.999KΩ	± 0.02% & one digit	100μa
100.00KΩ	to 999.99KΩ	± 0.05% & one digit	10μa
1.0000MΩ	to 9.9999MΩ	± 0.01%	1μa

Sensitivity: 100 μV per digit, decreasing to 1 mv per digit
Balance time: Typical, 3 seconds
Power: From Control Unit Model C-2 (or Model C-1 when used in systems requiring reference)

Cubic Corporation's electronic tracking systems keep tabs on U.S. defense agency missiles. The skill and experience responsible for the accuracy of these Space Age Cubic systems are also important engineering and production components of high-quality Cubic instruments. For a fast, prove-it-yourself demonstration of Cubic Digital Systems, write or call us or our nearest representative

CUBIC CORPORATION
5575 Kearny Villa Road, San Diego 11, Calif.

ELECTRONIC ENGINEERING WITH A DIMENSION FOR THE FUTURE

For more information circle **48** on inquiry card.

events

May 18-22

Seventh Meeting on Mass Spectrometry, sponsored by ASTM Committee E-14, Statler Hotel, Los Angeles, Calif. For information write A. G. Sharkley, Jr., U.S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Penna.

May 20-22

National Spring Meeting of Society for Experimental Stress Analysis, Sheraton Park Hotel, Washington, D.C. For information write Leonard Mordfin, P. O. Box 4996, Washington 8, D.C.

May 21-22

1959 Ohio Valley Instrumentation-Automation Exhibit & Symposium, sponsored by Cincinnati Section ISA. For information contact Richard Surkamp, 8846 Round Hill Rd., Cincinnati 36, Ohio.

May 21-27

International Convention on Transistors, sponsored by the Radio and Telecommunication Section of The Institution of Electrical Engineers, London, England. For information write I.E.E., Savoy Place, London W.C. 2, England.

June 9-12

National Material Handling Exposition, Cleveland Public Auditorium, Cleveland, Ohio. For information write Material Handling Institute, Inc., Suite 759, One Gateway Center, Pittsburgh 22, Penna.

June 13-23

International Conference On Information Processing, sponsored by UNESCO, Paris, France. For information write USICIP, Box 4999, Washington 8, D.C.

June 15-19

Symposium on Molecular Structure and Spectroscopy, sponsored by Dept. of Physics and Astronomy, Ohio State University, will be held on campus. For information write R. A. Oetjen, Ohio State University, Columbus 10, Ohio.

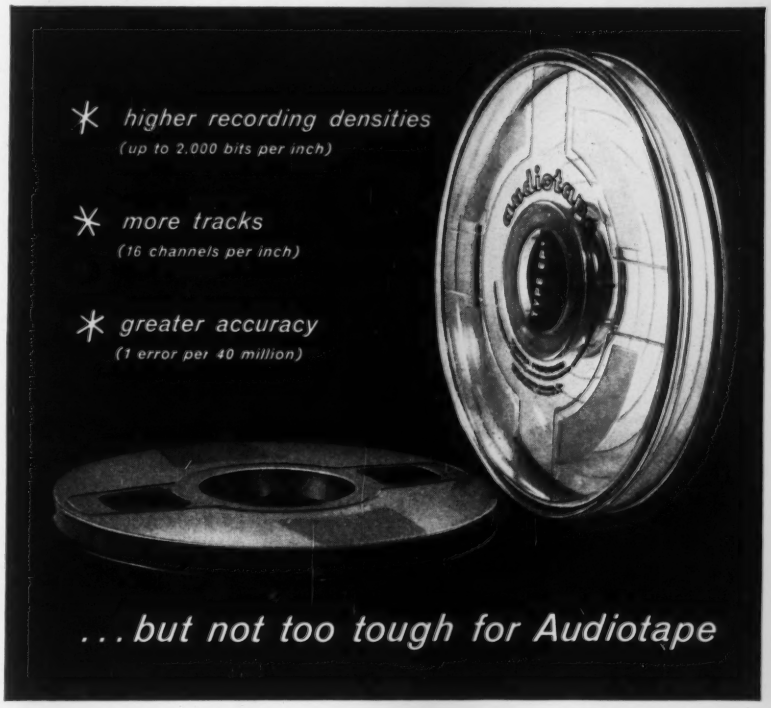
June 16-19

Industrial Engineering Seminars, sponsored by Cornell University, will be held on campus. For information write Andrew Schultz, Jr., Cornell University, Ithaca, N. Y.

June 17-19

I. S. A. Nuclear Instrumentation Symposium, Idaho Falls, Idaho. For information write H. S. Kindler, ISA, 313 6th Ave., Pittsburgh 22, Penna.

Tape specs are getting tougher every year


* higher recording densities
(up to 2,000 bits per inch)
* more tracks
(16 channels per inch)
* greater accuracy
(1 error per 40 million)
audiotape
. . . but not too tough for Audiotape

Keeping *ahead* of its customers is the only way a magnetic tape manufacturer can meet the rapidly rising standards being set for its product. And often the standards are as varied as they are exacting. Special slitting tolerances, coating thicknesses, base materials and magnetic oxides are rapidly becoming more usual than novel. Audio Devices' battery of Automatic Certifiers is one of the unique means used to make sure EP Audiotape always meets customer specifications.

Type EP Audiotape is the *extra precision* magnetic recording tape for applications in computing, automation, telemetering and seismography. The Automatic Certifier records and plays back every inch of the EP Audiotape under test. These tests can be so demanding that if the tape fails to reproduce a single test pulse out of the 40 million put on a single reel, the entire reel is rejected. There are no ifs, ands or buts.

This is one of many special quality-control operations to which EP Audiotape is subjected. From raw materials to hermetically sealed containers, every reel gets individual attention.

EP Audiotape quality is so well verified by instruments like the Automatic Certifier that every reel is guaranteed to be defect-free! For more information write for free Bulletin T112A. Write Dept. TI, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

TYPE EP audiotape TRADE MARK

AUDIO DEVICES, INC.
444 Madison Ave., N. Y. 22, N. Y.
In Hollywood: 840 N. Fairfax Ave.
In Chicago: 5428 Milwaukee Ave.
Export Dept.: 13 East 40th St., N. Y., 16
Rectifier Division: 620 E. Dyer Rd., Santa Ana, Calif.

For more information circle **49** on inquiry card.

New, Electro Instruments all-electronic, totally transistorized digital voltmeter

50 conversions per second • 1000 megohms input impedance • Fully automatic ranging

Model 8409 Voltmeter and Ratiometer

all the features you want in a medium-speed digital voltmeter

- 3 ranges, 9.999/99.99/999.9 volts
- Automatic, manual and remote ranging
- Automatic polarity
- One digit accuracy
- 4 digit in-line visual readout
- BCD and decimal electrical output
- Direct printer operation—local/remote control
- New 5¼" x 19" front panel
- Modular construction throughout
- Provision for external reference voltage

Plus accessory modules for every application

AC: All transistorized Model 110; considerably faster AC/DC conversion than presently available models. Fully automatic ranging and direct AC voltage readout on the Model 8409.

Ohmmeter: All transistorized Model KIM-000. Provides constant current through test resistor with negligible power dissipation. Voltage measurements made across resistor and read out directly in ohms with fully automatic ranging.

Also scanners, code converter modules, print control modules and many others to solve all digital problems—from simple voltmeter applications to complex data logging systems.

Ask your E I *representative for complete information.*

Electro Instruments, Inc.

3540 Aero Court San Diego 11, California

For more information circle **50** on inquiry card.

EVENTS—CONTINUED

August 17-28

Courses In Frontier Research On Digital Computers, sponsored by University of North Carolina, will be held on campus. For information write James G. Steagall, University Extension Div., Box 1050, Chapel Hill, N. C.

August 18-21

Western Electronic Show and Convention, San Francisco, Calif. For information write WESCON, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

August 24-26

Appalachian Gas Measurement Short Course, sponsored by University of West Virginia, will be held on campus. For information write School of Mines, Morgantown, West Virginia.

August 24-29

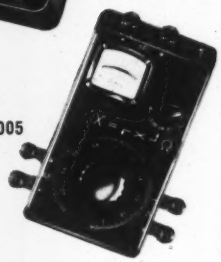
Infrared Spectroscopy Institute, sponsored by Fisk University, will be held on campus. For information write James R. Lawson, Fisk University, Infrared Spectroscopy Institute, Nashville, 8, Tenn.

November 16-20

Fifth International Automation Exposition, The New York Trade Show Building, 500 Eighth Ave., New York City. For information write Richard Rimbach Associates, Mgmt., 845 Ridge Ave., Pittsburgh 12, Penna.

PORTABLE BRIDGES

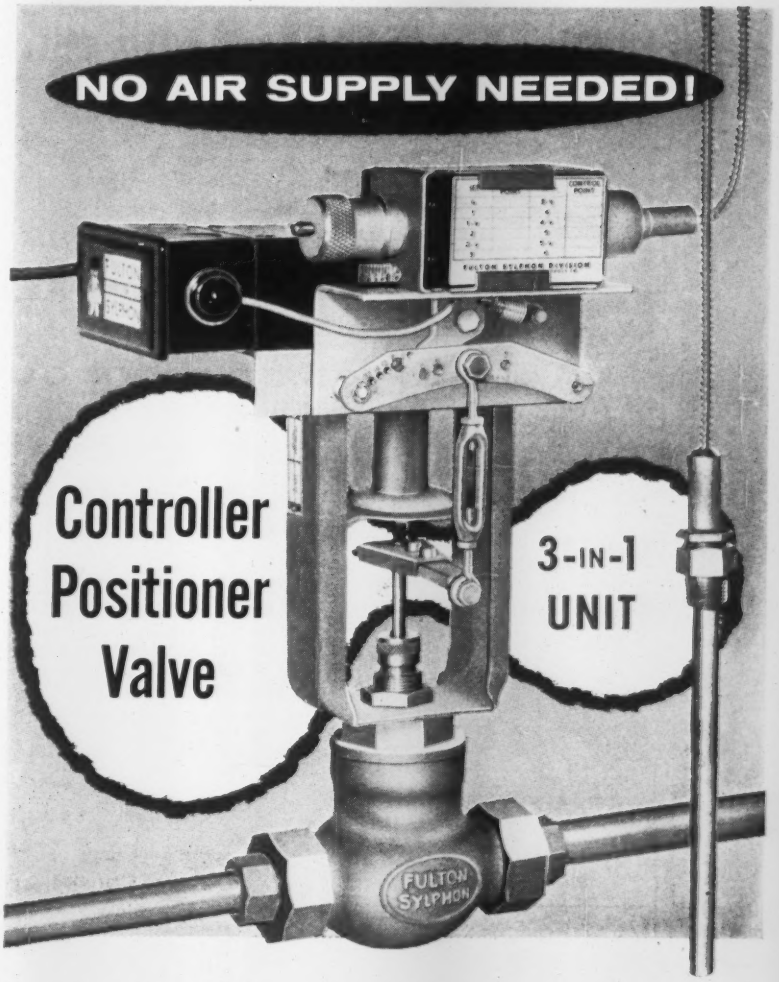
$115.00
Wheatstone
Range: 0.05
to 50,000 ohms



$175.00
Kelvin
Range: 0.00005
to 2.1 ohms

EPIC Inc. 154 Nassau St.
New York 38. N.Y.
DIgby 9-2470

For more information circle **43** on inquiry card.



Complete, Pre-assembled Electric Modulating Unit Controls Process Temperatures at Less Cost!

Right on the heels of the recently introduced FultroMatic air-actuated unit, Robertshaw engineers perfect this electrically operated version, the Fultro Lectric.

This low-cost combination Controller-Positioner-Valve provides modulating control of critical processes at about one-half the cost of two- and three-unit systems.

- **Dependable accuracy:** element responds to minute changes
- **Positive valve positioning:** no overshoot
- **Adjustable proportional band** easily changed on the job
- **Simplified settings:** easily reproducible
- **Field reversibility** for changing control action
- **Easy to install:** place valve in line, mount bulb, connect power
- **Low maintenance:** rugged design for trouble-free service

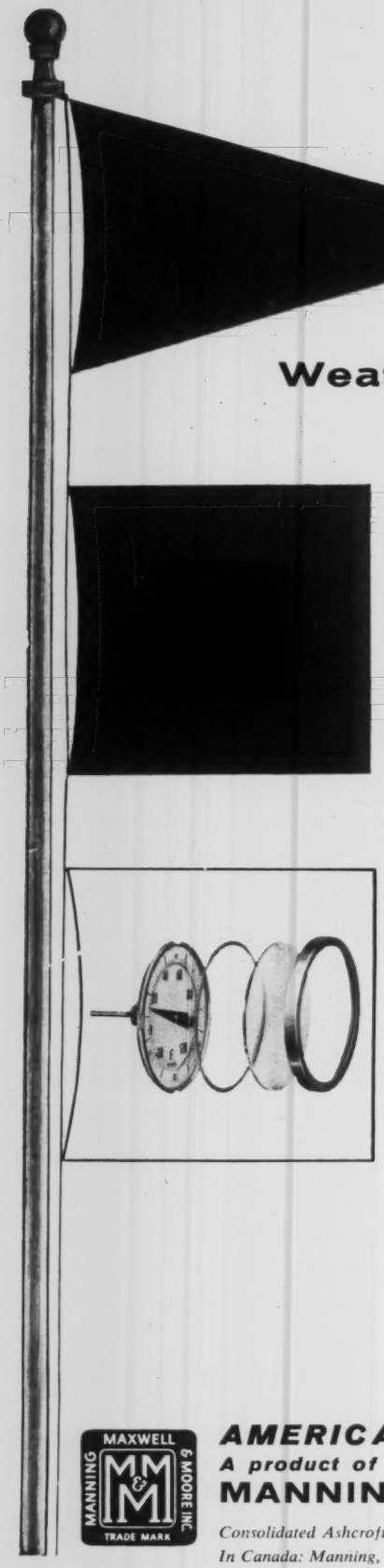
For complete details and specifications, write for Bulletin JL-756

Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tennessee

For more information circle **51** on inquiry card.



Weather-proof construction stymies erosion and corrosion

Complete protection against erosion and corrosion is built into American Bi-Metal Thermometers, so you can always be sure of accurate temperature measurement. Both case and bezel are stainless steel, precisely fitted and gasketed to insure snug mating. Whatever the weather, rain, sand, dust, dirt, fumes and frost are sealed out by a heat-resistant gasket between case and thick cover glass.

The stem of the American Bi-Metal Thermometer is mirror-smooth stainless steel. All joints are solidly welded. Top resistance to corrosion is teamed with strength, rigidity and tight closure against process pressures.

Weather-proof American Bi-Metal Thermometers are noted for high sustained accuracy and long service life. There are mounting styles, dial sizes, temperature ranges and stem lengths to meet your needs exactly. Ask your industrial supply distributor for help in proper selection.

American Bi-Metal Thermometer with weather-proof stainless steel construction.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

AMERICAN INDUSTRIAL THERMOMETERS

A product of

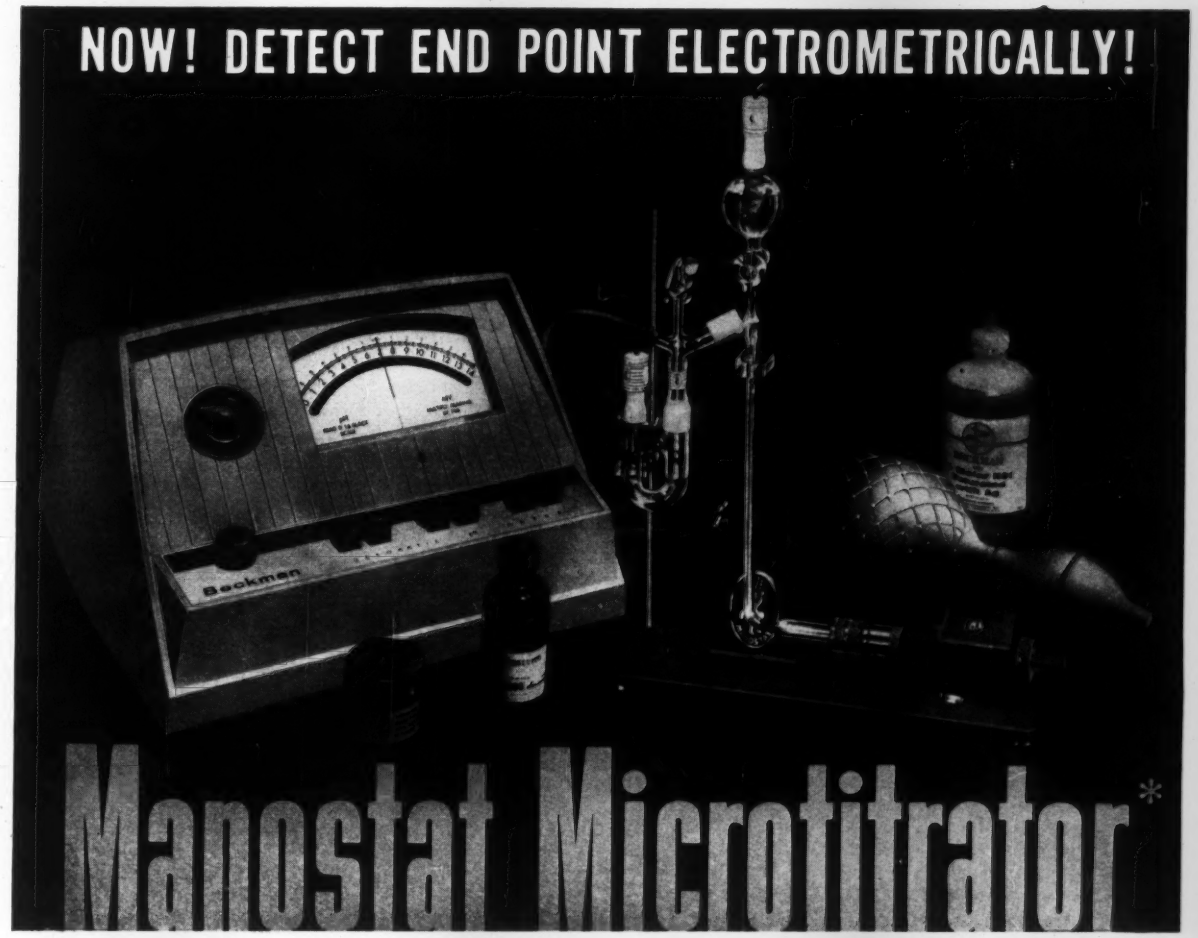
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **52** on inquiry card.

NOW! DETECT END POINT ELECTROMETRICALLY!



Manostat Microtitrator*

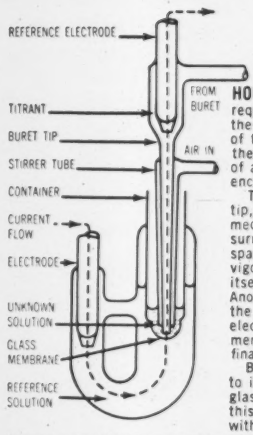
with Beckman® microelectrodes**

eliminates nerve-wracking uncertainty of visual detection!

Now...titrate such small quantities as *a single drop*—easily and *accurately*—with the Manostat Microtitrator, a modification of the Gilmont Ultramicroburet. The new Beckman Microelectrodes overcome the limitations of previous methods of titration, where larger quantities were required. And—this Manostat apparatus performs microtitration electrometrically, without need for visual adjustment of the end point.

The Manostat Microtitrator is capable of both oxidation-reduction titration as well as acidimetry-alkalimetry...with special electrodes for each process. It may be used with any high-impedance pH meter, such as the Beckman Zeromatic (shown in picture). The apparatus comes fully equipped with all accessories and solutions. Nothing else is needed but your pH meter.

**Patent applied for.*
***Manufactured exclusively for Manostat Corp.*



HOW IT WORKS: Electrometric titration of micro quantities requires a special type of electrode assembly which meets the space requirement. This is accomplished by a combination of the glass electrode membrane and container in one unit, the pH sensitive glass membrane being sealed to the bottom of a small test tube. This tube is then inserted into a reference electrode solution contained in a U tube.

To further meet the limitations of reduced space, the buret tip, salt bridge to second reference electrode, and stirring mechanism are all combined in one unit. The buret tip is surrounded by a second glass tube which forms an annular space through which air or an inert gas may be passed to vigorously agitate the solution being titrated. The titrant itself serves as the salt bridge to the reference electrode. Another electrode of similar construction is inserted into the U tube. The flow of current is therefore from this electrode through the reference solution, through the glass membrane to the unknown solution, then to the titrant and finally to the reference electrode.

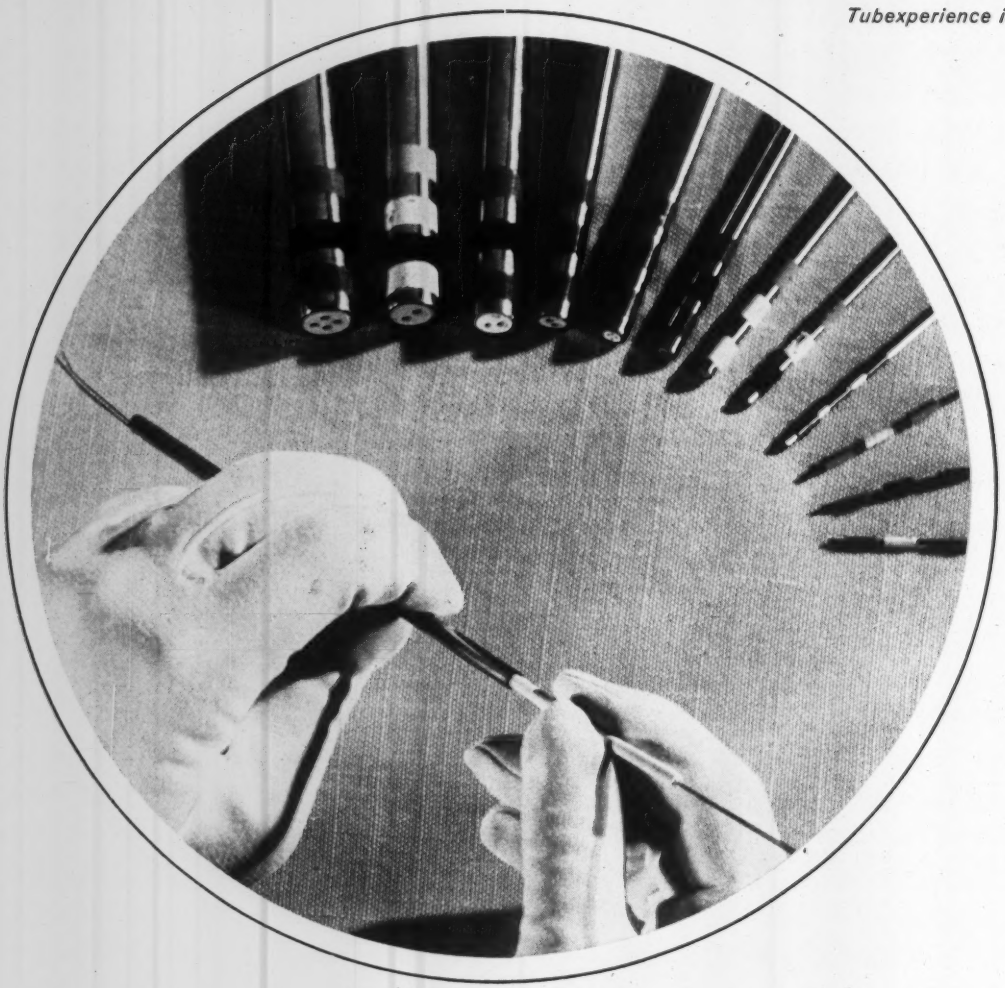
Because of the high resistance of the glass membrane to ionic flow, problems of electrical leakage enter when the glass electrode is separated into two containers. To reduce this leakage, all glass parts of the electrode are treated with a hydrophobic coating of silicone.

G 15654 MANOSTAT MICROTITRATOR, *complete with Beckman Microelectrodes and all accessories, but without pH meter* **245.00**

G 15655 MICROTITRATOR ACCESSORY KIT *contains all equipment necessary to convert a Gilmont Ultramicroburet to M15654* **128.50**

The EMIL GREINER Co. E&C Co.® **20-26 N. MOORE STREET DEPT. 230 N. Y. 13, N. Y.**

For more information circle **53** on inquiry card.



How clean ID of Superior tubing helped increase thermocouple electrical resistivity ratings

Tubing with unusually clean, smooth ID and produced to very close tolerances is a prime requisite for sheathing ceramic-pack thermocouples. Any irregularities will destroy the effectiveness of the finished product in protecting equipment and processes which it serves.

E. C. Smith Manufacturing Co., Conshohocken, Pa., relies on Superior to supply the tubing it needs to meet high-quality standards. The tubing ranges widely in sizes and analyses and includes many types of stainless steel in the 300 and 400 Series, Hastelloy,[1] Nichrome V,[2] "A" Nickel,[3] Inconel,[3] Monel,[3] 30% Cupro Nickel, and titanium. How well Superior tubing satisfies requirements is indicated by resistivity tests recently made. Thermocouples sheathed with Superior tubing were found to have electrical resistivity ratings that exceeded published standards by 1,000,000 megohms.

Superior's long experience in producing small tubing to meet rigid specifications in a broad range of analyses, sizes and shapes helped E. C. Smith Manufacturing Co. improve its product. It is doing the same for manufacturers in many different industries. For detailed information on this tubing and the ability of Superior to help you, write for a free copy of Bulletin 41. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

[1] Reg. T. M. Haynes-Stellite Co.
[2] Reg. T. M. Driver-Harris Co.
[3] Reg. T. M. International Nickel Co.

Superior Tube
The big name in small tubing
NORRISTOWN, PA.

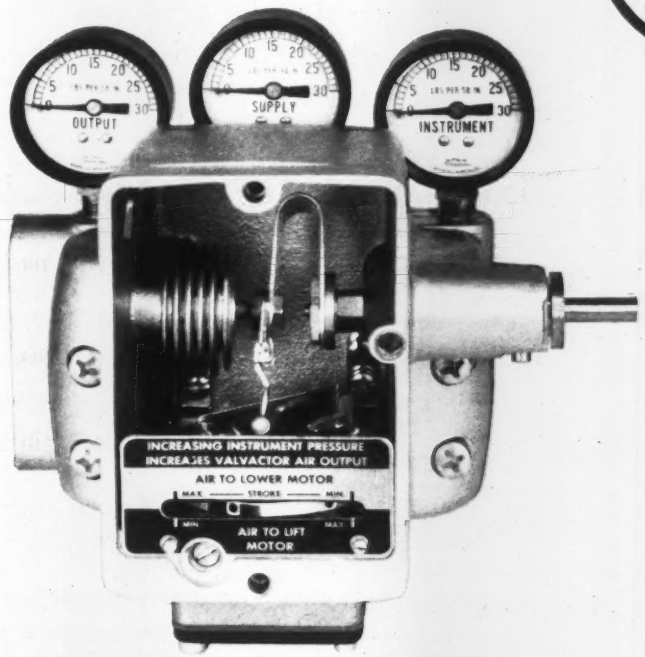
All analyses .010 in. to 5/8 in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

For more information circle **54** on inquiry card.

Foxboro Type C
VERNIER VALVACTOR*

MOST UNIVERSALLY ADAPTABLE VALVE POSITIONER ON THE MARKET!



The Type C Valvactor's distinctive motion-balance principle of stem positioning eliminates loading effects of heavy fixed-stroke actuating springs. Note compactness — the simplest mechanical design of any valve positioner.

**Trademark of a precision valve positioner made by The Foxboro Co.*

Unique Flexibility Easily reversible in seconds. Sequencing by two simple adjustments.

Super Response Full air-pressure output to diaphragm motor on signal air-pressure change as small as ½ of 1% of signal span.

Extra Speed New, high capacity relay provides high speed positioning action.

Positive Positioning Direct, motion-balance feed-back assures instantaneous, pin-point positioning.

Now there's a positive-action, super-precision valve positioner that you can easily adapt to *any* diaphragm motor application — without exchange of parts! It's the Foxboro Type C Vernier Valvactor with unique motion-feedback.

The Type C Valvactor has a master setting disc which provides easy change of action as required by the control system, as well as easy reversal of Valvactor action for air-to-open or air-to-close control valves. Adjusting for limited stem travel is equally simple ... sequencing of several valves is a cinch!

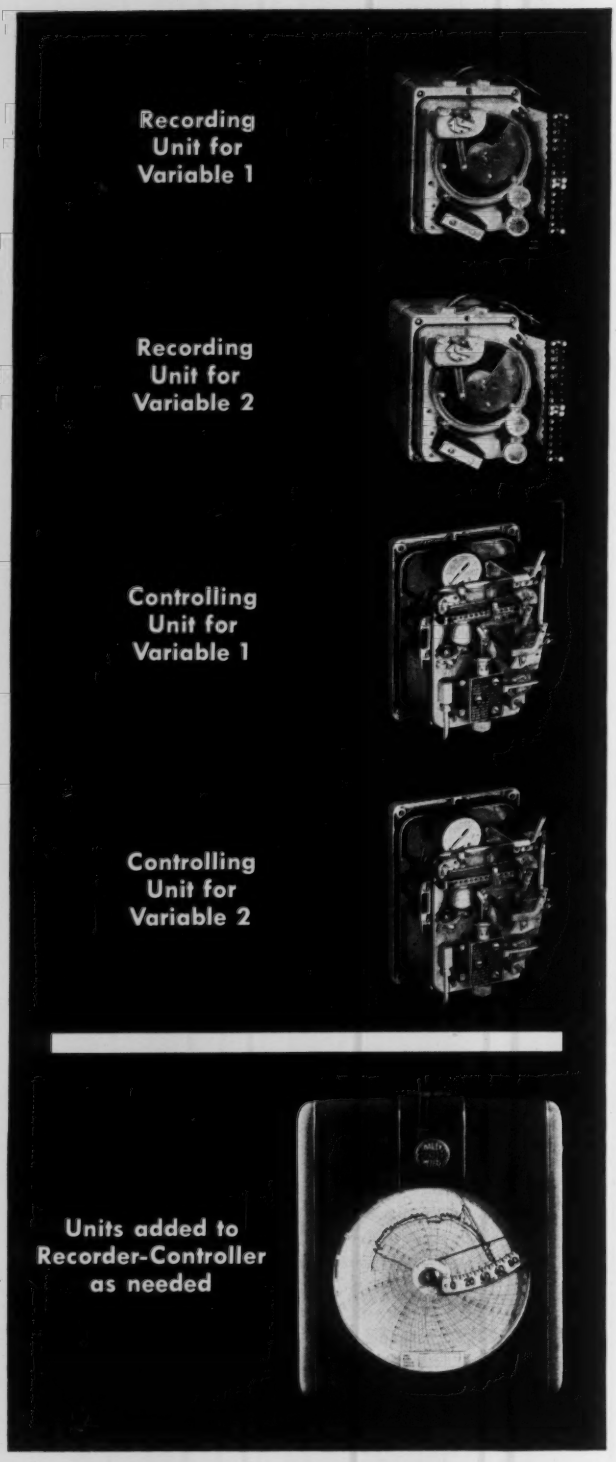
The Valvactor is the ideal solution to such problems as stem friction, plug friction, valve motor and transmission line lag, and extreme process line pressure changes. And it requires practically no maintenance! Available with 3-gauge and by-pass manifold, or plain manifold. Write for full details.

The Foxboro Company, 465 Norfolk St., Foxboro, Mass., U.S.A.

FOXBORO
REG U.S PAT OFF.

CONTROL VALVES AND POSITIONERS

For more information circle **55** on inquiry card.


Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer.

G-42-1

Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

For more information circle **56** on inquiry card.

For a wide range of applications in—

Communications

Data Processing

Automation

Model 28 RT Sets may be mounted in pairs in this newly designed Teletype Universal Cabinet, ideal for office or communications center installation.

New Teletype Model 28 RT Set

The Teletype Model 28 Reperforator Transmitter-Distributor Set features *three* facilities in one unit. It combines: (1) a typing or non-typing TAPE PUNCH . . . with (2) a TAPE READER . . . plus (3) intermediate TAPE STORAGE facilities.

This new equipment will accept 30 or 60 ma signals at line speed, convert them into perforations in paper tape, and retransmit the data at the same or another speed.

Speeds from 60 to 200 WPM are available for 5-level code. A manual gearshift permits selection of 60, 75 or 100 WPM, on units with either typing or non-typing tape punches. Units with non-typing tape punches operate at 200 WPM with a fixed gear arrangement.

The Model 28 RT is adaptable to a wide range of applications. For example:

Automatic Switching Systems. For high-speed, cross-office transfer of data.

Relaying. Between carriers or circuits.

Data Processing. Between terminal communications facilities and business machines.

If you would like more information about this new and versatile Teletype unit, please write for descriptive literature to: Teletype Corporation, Dept. 23-E, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company*, INC

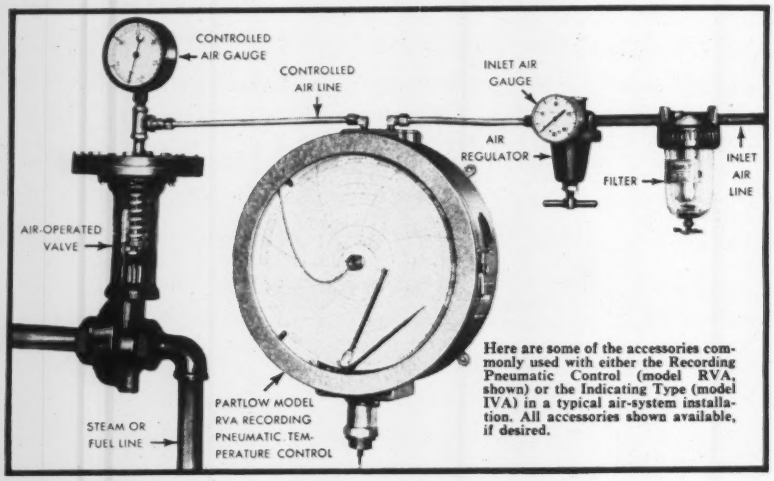
For more information circle **57** on inquiry card.

Introducing . . .

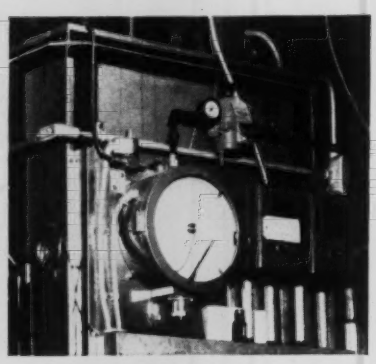
the NEW Partlow Pneumatic Control

New from Partlow . . . throttling-type pneumatic controls engineered to function with extreme accuracy, and sensitivity, under virtually *any* operating conditions.

Actuated as they are by the powerful, direct action of mercury, the Partlow pneumatics actually contain *fewer parts than any other pneumatic control on the market* . . . one reason why they're . . . . **Simpler to install • Simpler to maintain • Simpler to operate • Simpler to replace • and longer lasting, too.**



Here are some of the accessories commonly used with either the Recording Pneumatic Control (model RVA, shown) or the Indicating Type (model IVA) in a typical air-system installation. All accessories shown available, if desired.



MODEL RVA

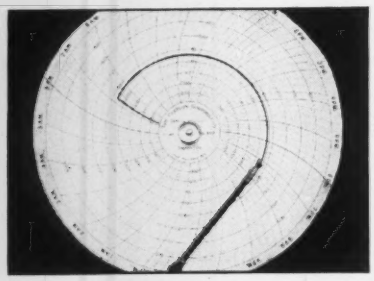
Pneumatic Recording control, installed on new steam-heated cross-flow dryer built by Lydon Bros., Hackensack, N. J.

OUTSTANDING FOR ACCURACY, SENSITIVITY AND FLEXIBILITY

The new Partlow pneumatic controls are accurate to within ½% of scale in any one of 10 ranges from –30° to 1100°F. *Exceptionally sensitive too* . . . providing positive, hair-trigger response even to fractional changes in temperature. *And flexible* . . . with throttling range adjustable anywhere from 3 to 20% of scale range.

COST LESS TO OWN AND OPERATE . . CUT "DOWN TIME" TO A MINIMUM!

Because they contain fewer parts, Partlow pneumatic controls cost less to buy: next to nothing to operate and maintain. *All elements of the same range are interchangeable*, which means they can be replaced right on the job instead of back in the factory . . . 'Down time' is reduced to a matter of minutes. And no expensive inventory of spare parts or spare instruments is ever required.



INSTANT RESPONSE

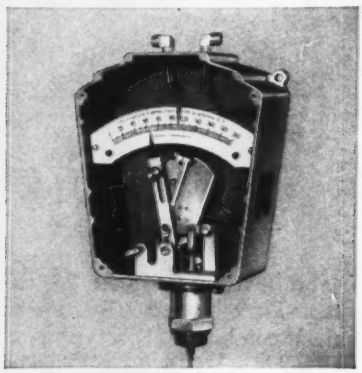
to temperature changes is a key feature of the Partlow pneumatic. Built-in bulb sensitivity teamed with advanced mechanism design means a minimum of saw-toothing on start-up and a fine line of control when the instrument has reached its throttling equilibrium.

IDEAL FOR HAZARDOUS OR 'SHOCK' LOCATIONS!

There are no delicate electronic tubes or gadgets in the Partlow pneumatic to get out of kilter, or possibly trigger an explosion. Its ruggedly simple internal mechanism is virtually shock-and vibration-proof . . provides maximum resistance to moisture, fumes, acid and all types of corrosion. Long-life and trouble-free performance are hallmarks of the pneumatics, as they are of all Partlow controls.

EXCEPTIONALLY VERSATILE TOO!

Both pneumatics — the Recording and the Indicating models — can be used in systems regulating the flow of steam, water or gas . . . or controlling other air-operated devices. Whatever the nature of the heating appliance it actuates, the chances are there's a Partlow pneumatic control to fit your requirements dependably . . . economically . . . *precisely*.



MODEL IVA (interior view)

New Partlow Pneumatic Indicating Control, with throttling range adjustable from 3 to 20%.

SEND US YOUR SPECIFICATIONS

Ask today for a control recommendation tailored for your specific requirements. Of course, if desired, you may field-test this superb new control without cost or obligation. For details write, wire or phone Dept. IA 559.

The Partlow Corp., New Hartford, N. Y.
Export: Ad. Auriema, Inc., 85 Broad St. New York 4, N. Y.

You can pay more but you can't buy better than

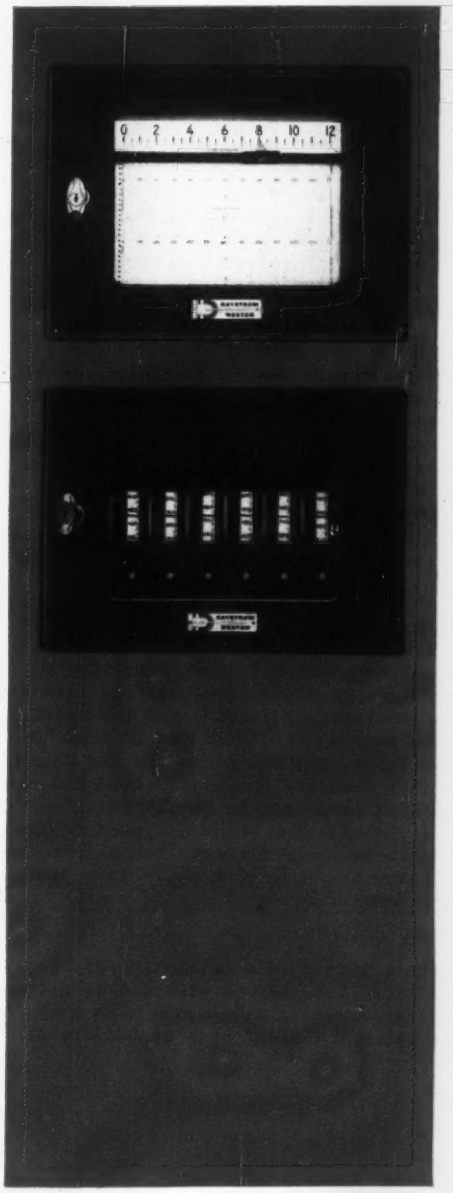
PARTLOW

TEMPERATURE CONTROLS

For more information circle **58** on inquiry card.

Pair 'em up

FOR GREATER ECONOMY



Looking for savings, without sacrifice of quality, in a multi-unit control and recording installation? If so, this Daystrom-Weston "package" is for you. Both units are exceptional in their own right . . . the most compact, maintenance-free, versatile instruments available. Together, the Model 6702-6134 combination costs less per point than any other type of recording-controlling potentiometric instruments. Both units employ the D-Pak® Constant Current Source, eliminating all standardizing mechanisms.

The Model 6134 Non-Indicating Multipoint Controller and the Model 6702 Multipoint Recorder each accommodate up to 6 separate imputs. (The latter can record as many as 18 additional points if desired.) Each control unit is unitized and independent . . . provides precise 2- or 3-position electric contact control.

Two distinctly separate circuits afford dual protection on overtemperature. Alarm circuits set for individual points in the Recorder provide high or low temperature cut-off as desired. Two separate or one common thermocouple can be used for each point – as the installation demands.

Control packages, including panels and accessories, can be suited to your specific application.

This exclusive space saving combination provides the finest in precision performance with

unmatched low cost!

For further information, contact your local Weston representative . . . or write to Daystrom-Weston Sales Division, Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

DAYSTROM WESTON

World leader in measurement and control

DAYSTROM-WESTON INDUSTRIAL INSTRUMENTS include a full line of recording and controlling potentiometers with strip and circular charts; mechanical recorders and indicators for pressure, temperature and flow; and non-indicating controllers, both electric and pneumatic.

For more information circle **59** on inquiry card.

HAGAN NEWSLETTER

Behind the Panel

3,850,000 LB/HR BOILER (WORLD'S LARGEST) TO HAVE HAGAN CONTROLS

TVA's Widows Creek Station will have a twin furnace boiler powering a turbo-generator rated at 500,000 KW, and is expected to go in service in mid-1960. The Hagan Control package for this giant boiler includes: combustion, 3-element feedwater and air heater temperature control systems, all principal metering, panel boards and automatic data processing system. The data system, supplied by Hagan's Kybernetes division, will continuously monitor 475 variables, and log 90 of these. In addition, any group may be selected for trend logging or demand logging. Each of these special functions may be initiated without interrupting the basic scanning which monitors for off-normal conditions. Of primary interest is the fact that the Kybernetes system is capable of adding integrating and computing control functions, so that completely automatic station operation is a future possibility. (Item E-1)

PERFORMANCE GUIDES SELECTION OF SINGLE CONTROL SUPPLIER

A major gas turbine manufacturer chose several manufacturers to supply control components, among them Hagan. As operating experience accumulated, it became evident that the Hagan components were superior in terms of reliability and accuracy. More and more Hagan components were specified, until today, the whole control package on every turbine is made up of Hagan equipment. Included are shockproof ratio totalizers, gas turbine thermostats, hydraulic toggle valves, sequential totalizers, and other Hagan components specifically engineered for the type of rugged service encountered by both stationary and mobile gas turbines. (Item E-2)

ALLOYS DEMAND PRECISE TEMPERATURE CONTROL DURING SOAKING

Soaking pits which are used for the heating of alloy steels must have a precision temperature control. The billets must be brought up to an exact temperature at a controlled rate; any over- or under-shooting of the desired temperature will have an adverse effect on the characteristics of the alloy. That is why Hagan fuel-air ratio, pit temperature and recuperator temperature controls were installed on a series of six new pits recently built by a major steel producer. The pits have been in service for nearly a year, heating alloy steels primarily, and operators are pleased with the performance of the Hagan controls. Required temperatures are reached at the proper rate, there is absolutely no over-shoot, and maintenance of the control equipment has been merely routine. (Item E-3)

WHEN "START-UP TIME" IS AN IMPORTANT FACTOR

Getting an installation going after construction is complete usually depends on how fast the control system can be put into operation. And that in turn usually depends on the skill and experience of the field engineer in charge. At a recent Hagan installation involving complete combustion control systems for twelve open hearth furnaces, sixty days of service time was included in the contract. The twelve furnaces are in excellent operation, and the total service time used amounted to only fifteen days. There are two reasons for this: one is that the Hagan field service engineer knew exactly what he was doing, and the second is the elegant simplicity of Hagan control components and the fact that they are shop calibrated and ready to go to work as soon as installed. This allows operating personnel to become familiar with the simple adjustments quickly and easily. At another installation which included combustion control, feed water control and principal metering on three large boilers, the superintendent stated that the thing he liked best about the systems was the ease with which they went into operation, and the excellent services rendered by the Hagan field engineer in charge. (Item E-4)

KYBERNETES DATA LOGGING SYSTEM FOR REFINERY

Scanning and providing visual readout of 100 temperature points in a catalytic reformer, this data system, designed and built by Hagan's Kybernetes division, can be expanded to accommodate readout of flow and pressure data. Installed to provide operating experience with data loggers in refinery operation, the system is seen as being the first step in the use of complete computer control. (Item E-5)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 704, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item E-1 — For more information on Item E-1 circle **60** on inquiry card.

☐ Item E-2 — For more information on Item E-2 circle **61** on inquiry card.

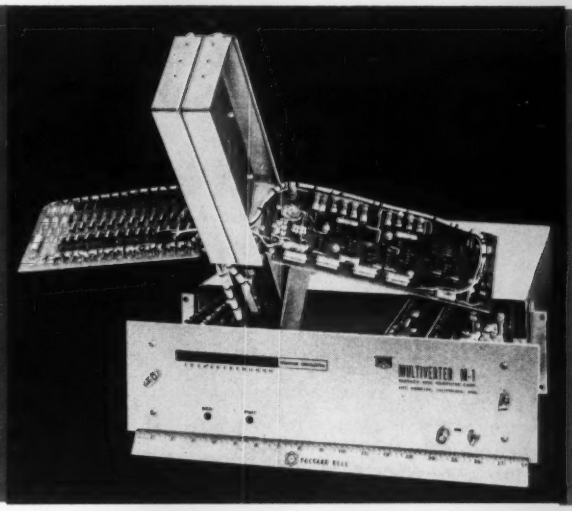
☐ Item E-3 — For more information on Item E-3 circle **62** on inquiry card.

☐ Item E-4 — For more information on Item E-4 circle **63** on inquiry card.

☐ Item E-5 — For more information on Item E-5 circle **64** on inquiry card.

SOLID BOTH WAYS

VOLTAGE-TO-DIGITAL

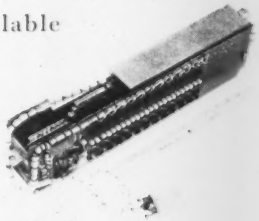


DIGITAL-TO-VOLTAGE

MULTIVERTER with compatible MULTIPLEXER and SAMPLE & HOLD—Completely Transistorized

Increasing speed, accuracy and reliability requirements of digital⇄analog conversion led Packard Bell Computer to develop the MULTIVERTER, the first completely solid state high speed (4 microseconds per bit) conversion system accurate to .01%—and the *only* conversion system with compatible solid state Multiplexer and Sample and Hold.

SELF-POWERED DIGITAL-TO-ANALOG CONVERTER



Among the several available MULTIVERTER Models is a self-powered Digital-to-Analog Converter with accuracies up to .01% and speeds of less than one microsecond.

PACKARD BELL COMPUTER CORP.
A subsidiary of Packard Bell Electronics

1905 S. Armacost Ave. • Los Angeles 25, California
GR 8-4247

For more information circle **65** on inquiry card.

panhandle pete *Recommendations by*

THE RECOMMENDED PRACTICES COMMITTEE
of the
INTERNATIONAL SOCIETY OF SYSTEMS ENGINEERS

A Compilation of Finagle's Universal Laws for Systems Engineers

Axiom #1 In any calculation, any error which can creep in will do so.
Axiom #2 Any error will be in the direction of most harm.
Axiom #3 In any formula, constants (especially from engineering handbooks) are to be treated as variables.
Axiom #4 The best approximation of service conditions in the laboratory will not begin to meet those conditions encountered in actual service.
Axiom #5 The most vital dimension on any plan or drawing stands the greatest chance of being omitted.
Axiom #6 If only one bid can be secured on any project, the price will be unreasonable.
Axiom #7 If a test installation functions perfectly, all susequent production units will malfunction.
Axiom #8 All delivery promises must be multiplied by a factor of 5.0.
Axiom #9 Major changes in construction will always be requested after fabrication is nearly completed.
Axiom #10 Parts that positively cannot be assembled in improper order will be.
Axiom #11 Interchangeable parts won't.
Axiom #12 Manufacturer's specifications of performance should be multiplied by a factor of 0.5.
Axiom #13 Salesmen's claims for performance should be multiplied by a factor of 0.25.
Axiom #14 Installation and Operating Instructions shipped with any device will be promptly discarded by the Receiving Department.
Axiom #15 Any device requiring service or adjustment will be least accessible.
Axiom #16 Service conditions as given on specifications will be exceeded.
Axiom #17 If more than one person is responsible for a miscalculation, no one will be at fault.
Axiom #18 Identical units which test in an identical fashion will not behave in an identical fashion in the field.
Axiom #19 If, in engineering practice, a safety factor is set through service experience at an ultimate value, an ingenious idiot will promptly calculate a method to exceed said safety factor.
Axiom #20 Warranty and guarantee clauses are voided by payment of the invoice.

NOTE: While the accuracy of the above Axioms is vouched for, the Committee does not feel that this compilation is by any means complete. The Committee will welcome any additions conforming to good systems engineering practice to the list.

Bougar T. Factor, Chairman

INTERNATIONAL SOCIETY OF
SYSTEMS ENGINEERS
3.1416 HOGWASH AVE., OIL CITY, PA.

THIS IS TO CERTIFY THAT

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HAVING SUCCESSFULLY PASSED A THOROUGH EXAMINATION ON FINNAGLES LAWS, MISREADING BLUEPRINTS AND UNDERESTIMATING COSTS AND COMPETITION, IS HEREBY ENTITLED TO PRACTICE ALL FORMS OF SYSTEMS ENGINEERING, ADVANCED SIDEWALK SUPERINTENDING, AND DO-IT-YOURSELF CONSTRUCTION.

Annual Dues $1.00

Bougar T. Factor, President
No. ..... **Panhandle Pete, Secretary**

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J. B. Caldwell
The Okonite Company
701 Phelps Street
San Francisco 24

Canada
Robert Muddiman Co., Ltd.
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Montreal

Robert Muddiman Co., Ltd.
58 St. Clair Ave., E.
Toronto

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Savannah

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Instruments Associates
7943 S. Exchange Ave.
Chicago 17

Massachusetts
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8030 Manchester Road
St. Louis 17

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Oklahoma
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Tulsa

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33rd & Arch Streets
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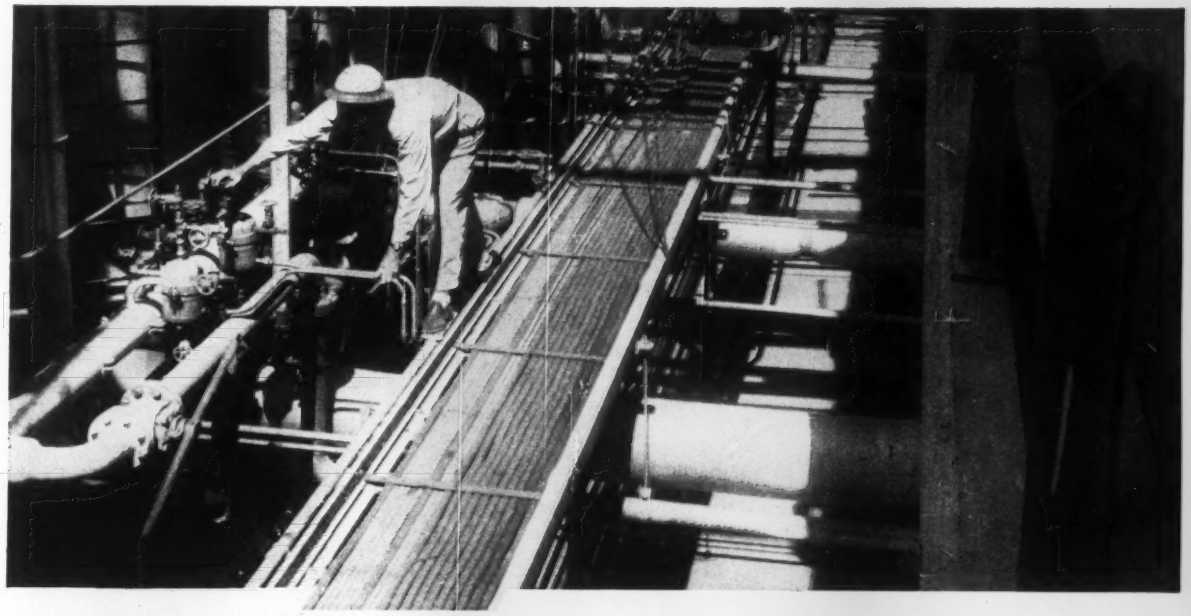
All-South Sales & Engineering Co.
P. O. Box 5271
Memphis 16

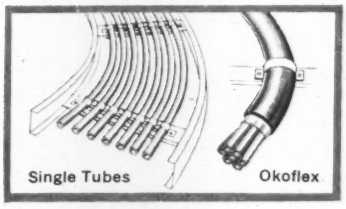
Texas
J. K. Moore Company
3115 Leeland Avenue
Houston 3



New 3-WAY approach reduces cost of instrument tubing

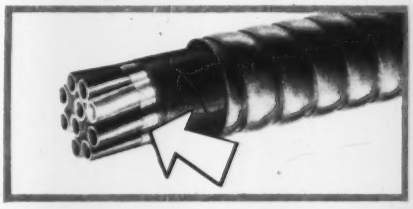
New Okoflex® armored instrument tubing costs less to install than single tubes, yet gives vastly increased resistance to corrosion and mechanical abuse. In addition, **Okoflex costs no more than ordinary multiple instrument tubing.**

Here is the Okoflex three-way approach to reducing your instrument tubing costs:



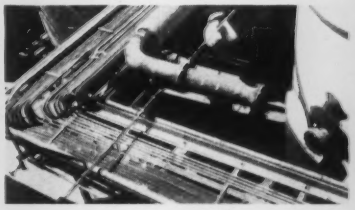
1. Lower installation cost

An Okoflex assembly, consisting of several tubes, takes about the same time to install as a single tube. Existing structures can be used for support, and standard fittings are used for attachment. Armored Okoflex can be "fished" quickly through inaccessible or hazardous locations without fear of tube damage. In addition, Okoflex can be taken down and used over and over again. It is completely salvageable.



2. More durability

Only Okoflex has a Mylar® tape over its core of tubes. This DuPont polyester film provides *extra* protection against both environmental corrosion and galvanic action between the tubes and a metallic covering. One of several Okoflex coverings—each designed for a specific situation—protects the tubes from both physical damage and corrosion. All tubes are tested at not less than 150 psi prior to cabling, and every foot of an Okoflex corrosion-resistant sheath is electrically tested at 4,000 volts to insure that no perforations are present.



3. Tube flattening eliminated

Okoflex cabled tubes—spiraled like strands of rope—can be bent on a small radius without distortion or flattening. Circular in shape, Okoflex' smooth exterior permits easy water and vapor-tight connections with standard fittings. Stresses are distributed evenly to give excellent resistance to mechanical abuse. And on delivery, you'll find that *every* tube is usable . . . none bent or damaged.

For engineering information and prices, contact the Okoflex distributor nearest you. He is listed on the opposite page.

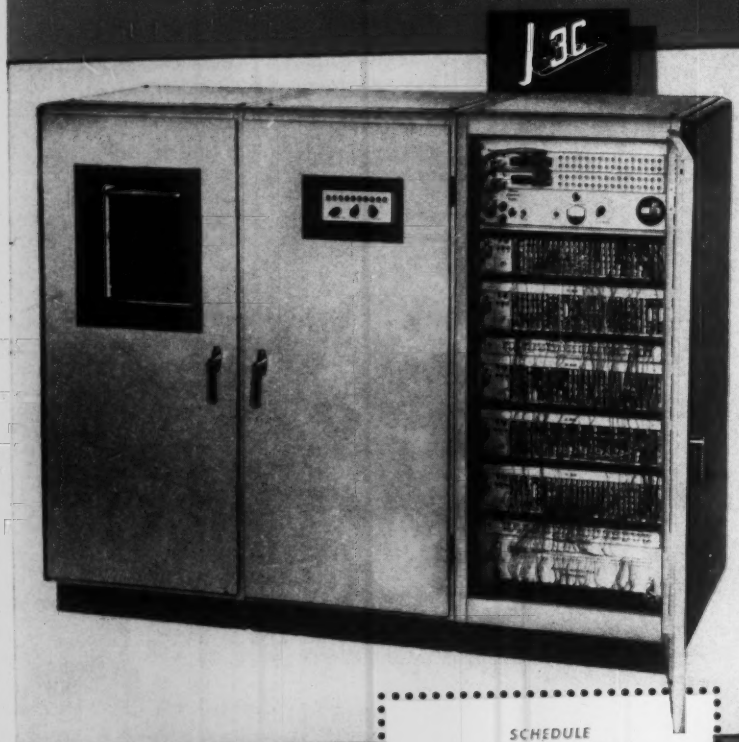
THE OKONITE COMPANY
Subsidiary of Kennecott Copper Corporation
Passaic, New Jersey

OKOFLEX . . . the low cost way to install instrument tubing

6902

For more information circle **66** on inquiry card.

FROM START OF LOGICAL DESIGN
TO COMPLETED SYSTEM IN MONTHS



TYPICAL PROBLEM:
A room project to implement a high speed digital data handling or computing system.

OPTIMUM SOLUTION:
Standard T-PAC digital modules by Computer Control.

T-PACs:
Transistorized • compact • plug-in modules • etched circuits • taper pin solderless connectors • one megacycle repetition rate • standard waveform throughout • reliable • no external-to-the-package coupling components • fully guaranteed •

SCHEDULE TIMESAVERS:

With T-PACs you go directly from your logical design to system wiring.

Wiring is rapid, reliable, and permanent; yet, is easy to modify at any time.

System debugging is routine, thanks to standard logical elements and standard waveforms.

Write for product catalog

COMPUTER CONTROL Co., Inc.

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WESTERN DIVISION
2251 BARRY AVENUE • LOS ANGELES 64 • CALIFORNIA

For more information circle 68 on inquiry card.

book reviews

Scientific and Industrial Glass Blowing and Laboratory Techniques, by W. E. Barr and Victor J. Anhorn, (c1959) Instruments Publishing Company, 845 Ridge Ave., Pittsburgh 12, Penna. 380 plus xxviii pages. $5. New revised, up-to-date edition covers construction in detail. Explains operating principles of all pieces. Includes review of history and most recent developments. 300 illustrations.

Television in Science and Industry, by V. K. Zworykin, E. G. Ramberg, and L. E. Flory. [c1958.] John Wiley & Sons, New York 16, N.Y. 300 p. $10. 9¼ in. Discusses the fields of application of closed-circuit television, the essential apparatus including color and stereo television and the television microscope. Reviews the achievements in industry, physical and engineering research, medicine and biology, commerce, and military uses.

Sourcebook on Atomic Energy, ed. 2 by Samuel Glasstone. [c1958.] D. Van Nostrand Co., Princeton, N.J. 641 p. $4.40. 9¼ in. Author is consultant to the U. S. Atomic Energy Commission which sponsored the first edition (1950) and has requested this revision. This edition has a new chapter on nuclear reactors.

The Junction Transistor and Its Applications, edited by E. Wolfendale. 1958. Macmillan Co., New York 11, N.Y. 394 p. $7.50. 9½ in. Based on the experience of a group of engineers and physicists who have long worked with semiconductors and their applications. Deals with physics and characteristics of transistors and with design of circuits.

The Atom and the Energy Revolution, by Norman Lansdell. [1958.] Philosophical Library, New York 16, N. Y. 200 p. $6. 9½ in. Considers the atom, its energy, and methods of releasing it, materials for development of atomic energy, exploitation of atomic energy by separate countries and international organizations, hazards and insurance, and impact on the world in general.

Impedance Matching, edited by Alexander Schure. [c1958.] John F. Rider, New York 11, N.Y. 119 p., unbound. $2.90. 8½ in. Deals with impedance matching at audio frequencies, radio frequencies and in transistor circuits, and considers devices commonly used in transfer of energy from the "source" or "generator" to the "load."

Circle 69 on inquiry card. →

Now, from the Laboratories of CLARE,

THE MOST EXCITING RELAY DESIGN OF THE YEAR

NEW *SIX-IN-LINE* HG6F RELAY BRINGS BIG SAVINGS IN SPACE, POWER, AND COST

Latest in the Clare line of Mercury-wetted Contact Relays, world famous for their billions of operations*, is Type HG6F, a six-in-line flat-pack relay. This striking new design provides the most reliable, durable, maintenance-free relays ever made anywhere, *plus these savings.*

Compact CLARE TYPE HG6F Relay ready for mounting. Overall dimensions: 3.640"x3.125"x1.046".

SAVES SPACE–

Unique packaging affords up to 50% savings in space over cylindrical multi-element mercury-wetted contact relays.

SAVES POWER–

Six switches per coil saves operating power.

SAVES COST–

Switch cost as much as 26% below cost of same number of switches in cylindrical packages.

*Mercury-wetted contact relays on test have completed over 8 billion operations with a contact-load of 250 volt-amperes, and are still going strong.

MECHANICAL FEATURES

Flat, rectangular package makes most efficient use of chassis space.

Printed circuit mounting eliminates customary internal wiring except for coil leads.

Units can be stacked in line without interaction.

No shelf deterioration; requires no maintenance.

Contacts cannot wear, get dirty, stick by locking or welding, nor chatter.

Tamper proof.

Completely protected against dust and dirt, corrosive fumes, and explosive atmospheres.

No mechanical damage when subjected to usual military shock and vibration tests.

ELECTRICAL FEATURES

Life expectancy measured in billions of operations.

No contact chatter or bounce.

Low and consistent contact resistance.

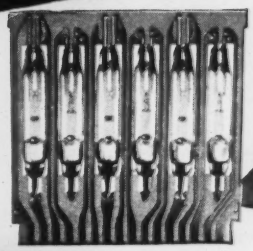
Full line of coil resistances.

Contacts rated at 5 amperes, 500 volts (d-c or rms)

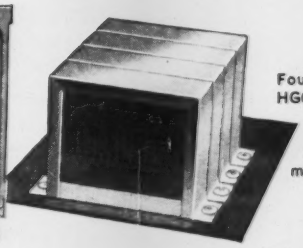
Product of voltage prior to closing and current prior to opening, 250 volt-amperes maximum.

Nominal operating time: 1 watt input, 11 milliseconds; 2 watts input, 7 milliseconds; 4 watts input, 5 milliseconds.

Release time: 4 milliseconds or less. Maximum continuous dissipation: 5 watts at 100° F.



Arrangement of six-in-line mercury-wetted contact switches on printed circuit panel.



Four CLARE Type HG6F relays mount in a space 50% less than cylindrical multi-element assemblies.

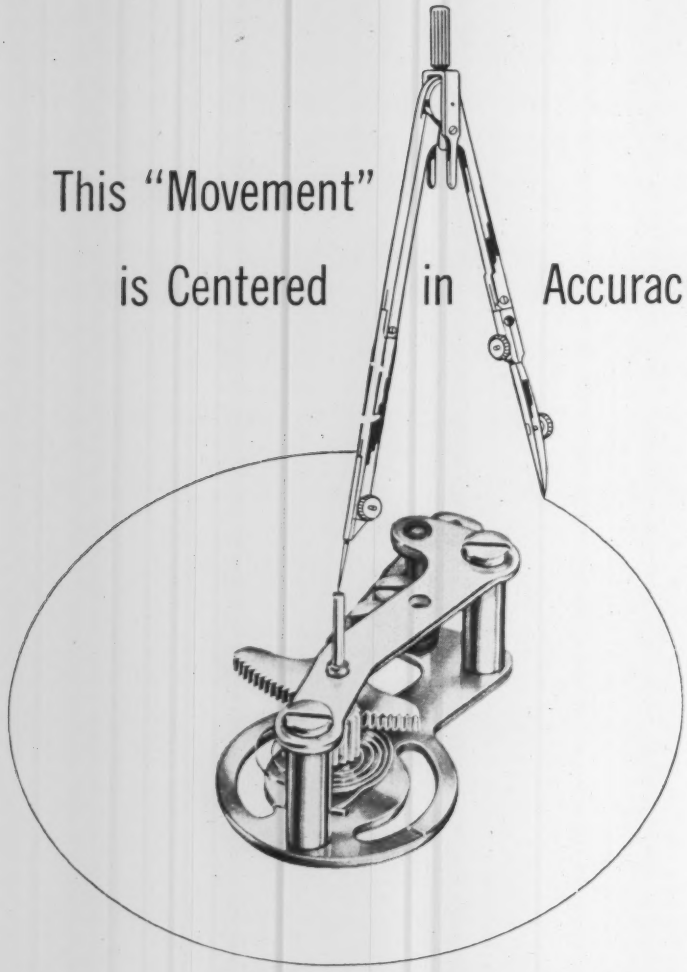
SEND FOR BROCHURE CPC-2

For complete information, contact C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY

CLARE RELAYS

FIRST in the industrial field

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case – a lifetime case made of special aluminum alloy.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **70** on inquiry card.

Engineered WEIGHING SYSTEM NEWS

HYDRAULIC CELLS "NATURALLY" DAMPEN OUT OSCILLATIONS OF VIBRATORY LOADS

Precision weighing of a vibratory load poses a troublesome problem for the instrument man. This is particularly true if the oscillations of the vibrations are irregular in both magnitude and time.

Where effort is made to use electrical load cells to do this job, filters are employed. In many instances, the drift of the filter is greater than the desired measurement.

Engineering-wise it is a well-known fact that oil has within itself the natural property of dampening out vibrations. This, plus the proper engineering of tubing and valves, make the Emery Engineered Weighing System the most effective method available today for solving the problem of dampening out troublesome vibrations to give precision weighing of vibratory loads.

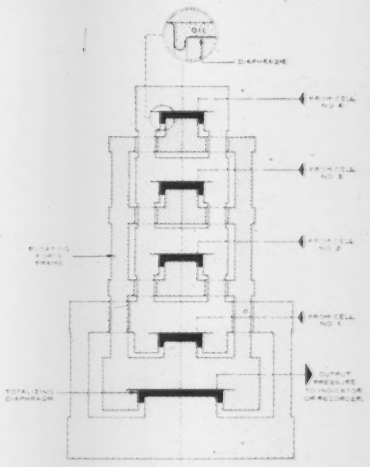
When writing, refer to Item 1009

WAY-PAC LOAD TOTALIZER UNIT COMBINES HYDRAULIC CELL LOADS

The new, simple, self-contained Emery WAY-PAC Load Totalizer Unit, a device for combining the loads on two, three, or four WAY-PAC Cells, has a sensitivity of 1 part in 5,000 and will accept the maximum capacities of both the 1,000 lb. and the 5,000 lb. cells. It is shock resistant, weather-proof, and is not affected by temperature variations.

Measuring 9½" in overall height, the totalizer contains diaphragms each of which exerts a load on a floating force frame. The force frame, in turn, exerts this total load on the totalizing diaphragm where it is again converted into a combined output hydraulic pressure which represents the combined load on two, three, or four WAY-PAC cells. All types of indicating, recording and controlling instrumentation may be used in conjunction with the WAY-PAC Load Totalizer.

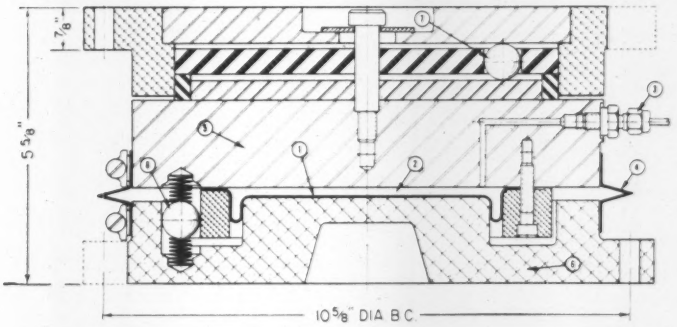
When writing, refer to Item 1006



WAY-PAC LOAD TOTALIZER

The new WAY-PAC Load Totalizer combines the loads on two, three or four WAY-PAC Load Cells.

WAY-PAC HYDRAULIC CELL LINE IS NOW EXPANDED TO 5,000 LB. CAPACITY



1 DIAPHRAGM 2 OIL 3 OIL FITTING 4 PROTECTIVE BOOT (neoprene)
5 BAR STOCK ALUMINUM 6 CAST ALUMINUM 7 ROLLING BALL 8 POSITIONING BALLS

Cross section of the new 5,000 lb. capacity WAY-PAC Compression Cell with the exclusive Emery "rolling ball head" (Type AC-5-RB).

The recently-introduced line of Emery WAY-PAC Hydraulic Load Cells has now been expanded to include capacities of 5,000 lbs. The original WAY-PAC line was limited in its rating up to 1,000 lbs.

The WAY-PAC 5,000 lb. cells are similar to the previous 1,000 lb. cells in manufacture but the new dimensions are different. Included in the line are: the AC-5, Compression; the AC-5-RB, Compression with "rolling ball" head; the AU-5, Tension; the AT-5, Cable Tension; and the AD-5, Strut Cell. The same instrumentation which teams up so well with the 1,000 lb. series works equally well with the new 5,000 lb. line.

When writing, refer to Item 1008

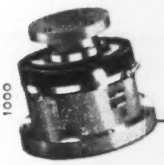
NEW 19½" DIAL INDICATOR WILL IMPROVE ACCURACY OF CELL PRESSURE READINGS

Taking pressure readings with increased accuracy is much easier with the new Emery 19½" dial indicator. Previously, the largest dial offered measured 16½" in diameter.

Since the basic objective of dial reading is accuracy, our 19½" indicator makes possible greater accuracy than ever before. Because of the larger scale length, graduations can be better matched to the job. Easy and accurate readings are a basic advantage with the new Emery 19½" indicator.

When writing, refer to Item 1007

The A. H. Emery Co., New Canaan, Conn.
I am interested in the following:
Item 1006 ☐ Item 1008 ☐
Item 1007 ☐ Item 1009 ☐
Seeing Representative ☐
Name .....
Title .....
Company .....
Address .....
City ..... State .....

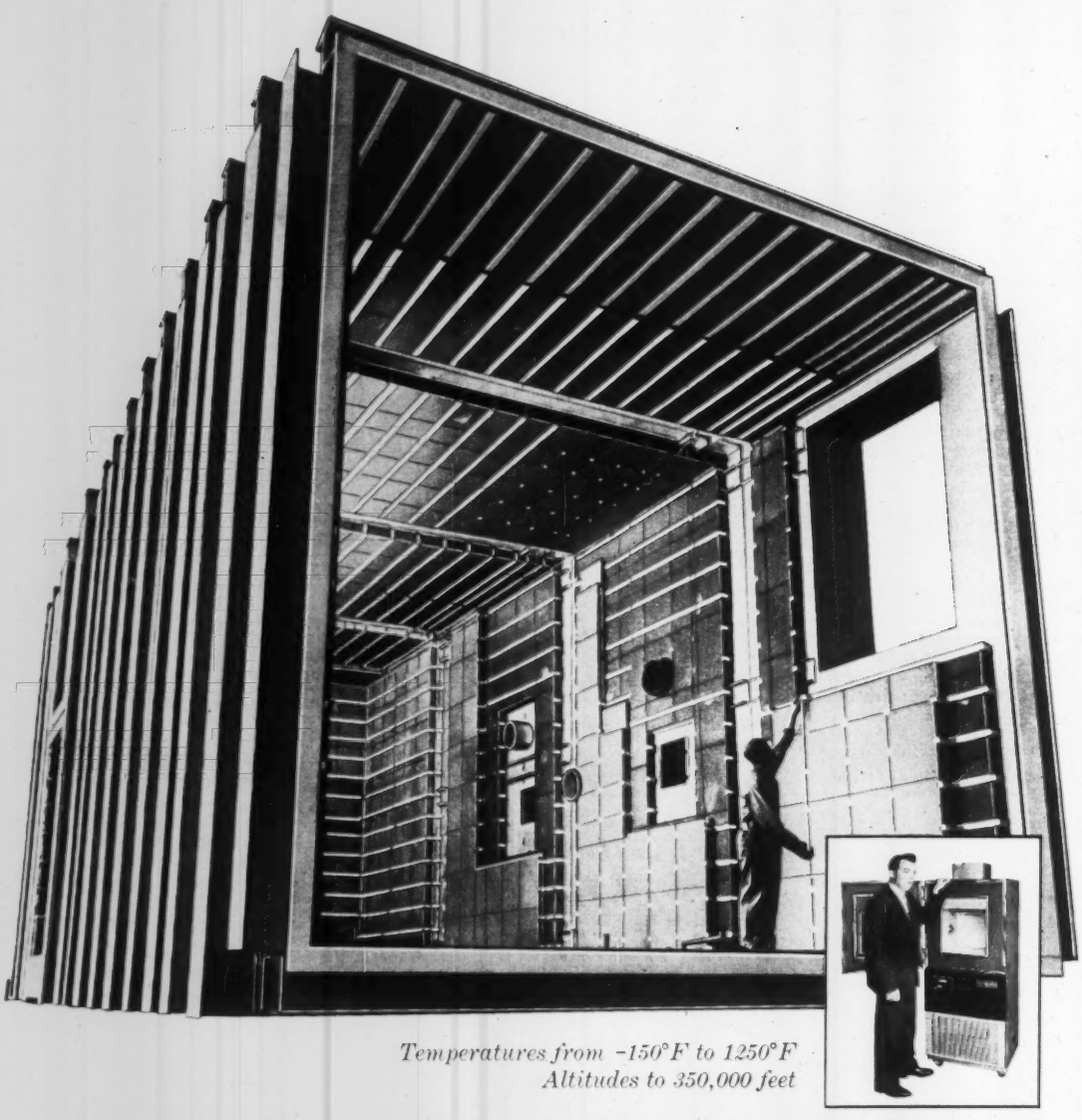


1000

THE A. H. EMERY COMPANY
New Canaan, Conn.

Engineered WEIGHING SYSTEMS

For more information circle **71** on inquiry card.

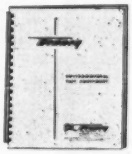


Temperatures from -150°F to 1250°F
Altitudes to 350,000 feet

TENNEY OFFERS WIDEST RANGE OF ENVIRONMENTAL TEST EQUIPMENT

Picture a test chamber as large as a house; imagine another as small as a typewriter; then think of the range of sizes between these extremes. Now you have an idea of the tremendous size-range of environmental chambers that Tenney has produced for companies all over the world.

The range of uses is just as wide! Altitude, temperature, humidity, alone or in combinations, as well as explosion, sand, dust, fog and any other possible environment, can and have been accurately simulated in Tenney chambers. No wonder Tenney produces more chambers than any other company in the field!



Write for a descriptive catalog and complete information on Tenney's research and development, engineering consultation, and design services.

Tenney ENGINEERING, INC.

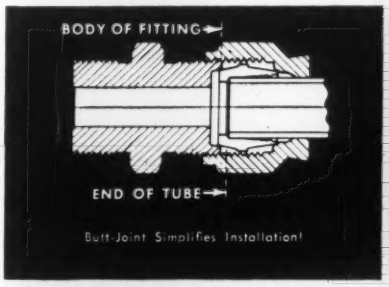
WORLD LEADER IN ENVIRONMENTAL TEST EQUIPMENT

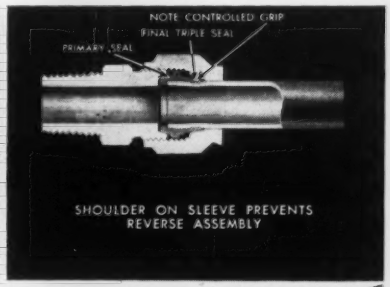
1090 SPRINGFIELD ROAD, UNION, N. J.
PLANTS: UNION, N. J. AND BALTIMORE, MD.

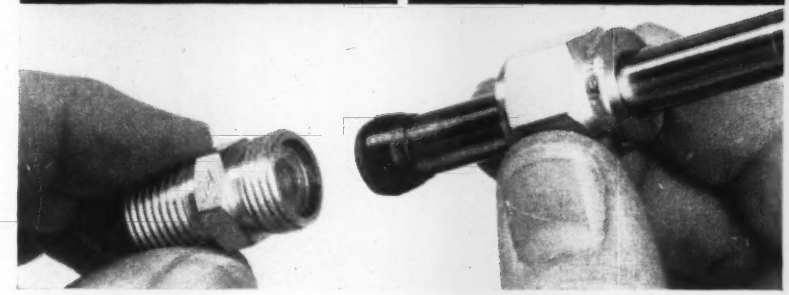
For more information circle **72** on inquiry card.

IMPERIAL *Engineering and Data File*

ENGINEERED TUBE FITTINGS — VALVES — TUBING TOOLS



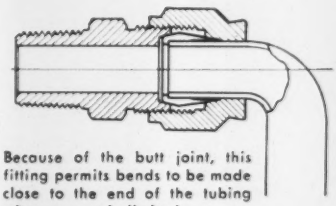




How Hi-Seal tube fitting design simplifies instrumentation piping layouts

The butt-joint feature of Hi-Seal fittings is a design consideration acclaimed by fitting users throughout industry. The tube *does not* enter body of fitting! It bottoms on the shoulder of the sleeve. This butt joint feature makes possible far more compact piping layouts than other fittings.

Users have obtained these benefits: (1) cuts space requirements up to 50%; (2) reduces number of bends required; (3) cuts man hours and installation time; (4) substantially reduces the amount of tubing needed; (5) permits the use of straight lengths of .028″ copper tubing in bending temper instead of .032″ soft tubing in coils; (6) ends need for straightening.



Because of the butt joint, this fitting permits bends to be made close to the end of the tubing where space is limited.

FOOLPROOF ASSEMBLY — Anyone can make leakproof connections with Hi-Seal fittings. There is only one way to assemble the Hi-Seal fitting . . . only one way tubing can go into sleeve . . . only one way sleeve can go into fitting.

Hi-Seal design also makes maintenance of equipment easier through quicker disassembly and assembly of joints — may be disconnected and reconnected as often as desired.

COMPLETE LINE — Hi-Seal fittings are available in brass, steel, stainless steel. Also can be furnished in Titanium, Tantalum and other metals. Steel fittings supplied with cadmium plate or black phosphate finish. Conform to J.I.C., A.S.M.E. and A.S.A. standards. In sizes for ¼″ to 1½″ O.D. tubing. Furnished with Long Dryseal pipe threads or straight thread port seal.

Write for Bulletin No. 3061

New high-pressure valves assemble directly to tubing, eliminate additional fittings

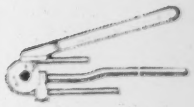
A revolutionary new line of Imperial needle valves designed for working pressures up to 5,000 psi., and temperatures to 450° F., employs Hi-Seal tubing connections.

These valves attach directly to tubing and eliminate additional fittings. This not only reduces cost but cuts installation time and eliminates principal source of leakage.

For low pressure instrumentation service, Imperial also supplies a complete line of fluid control valves in diaphragm, plug, (2, 3, and 4-way styles) — needle and toggle types.

Write for Bulletin 3096, or Catalog No. 200

Dimensional Bends easily made with Imperial Blue Dot Benders



It's no trick to make bends at any desired point — that conform to dimensional requirements as to developed tube length and location — when you use Imperial Blue Dot Benders. Full instructions with each bender.

Imperial Benders are of the open side type. They slip over the tubing where the bend is desired — handy in hard-to-get-at places or when tubing has one end connected.

They form neat, accurate bends on hard or soft tubing without annealing. Calibrated for bending any angle up to 180°.

Wide range of individual and combination benders for 2 to 7 sizes — from ⅛″ to ⅜″ O.D. (⅛″ to ¾″ nom.).

Write for Bulletin No. 3088

CONTACT YOUR INDUSTRIAL DISTRIBUTOR OR WRITE TO:

THE IMPERIAL BRASS MFG. CO.
Dept. ICS-59, 6300 W. Howard St., Chicago 48, Ill.

Please rush me: Bulletins ☐ No. 3061 ☐ No. 3096 ☐ No. 3088 ☐ Cat. No. 200

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Visit our Booth No. 1538 at the Design Engineering Show

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THE IMPERIAL BRASS MFG. CO.
6300 W. Howard St., Chicago 48, Illinois
In Canada: 18 Hook Ave., Toronto, Ontario

For more information circle **73** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

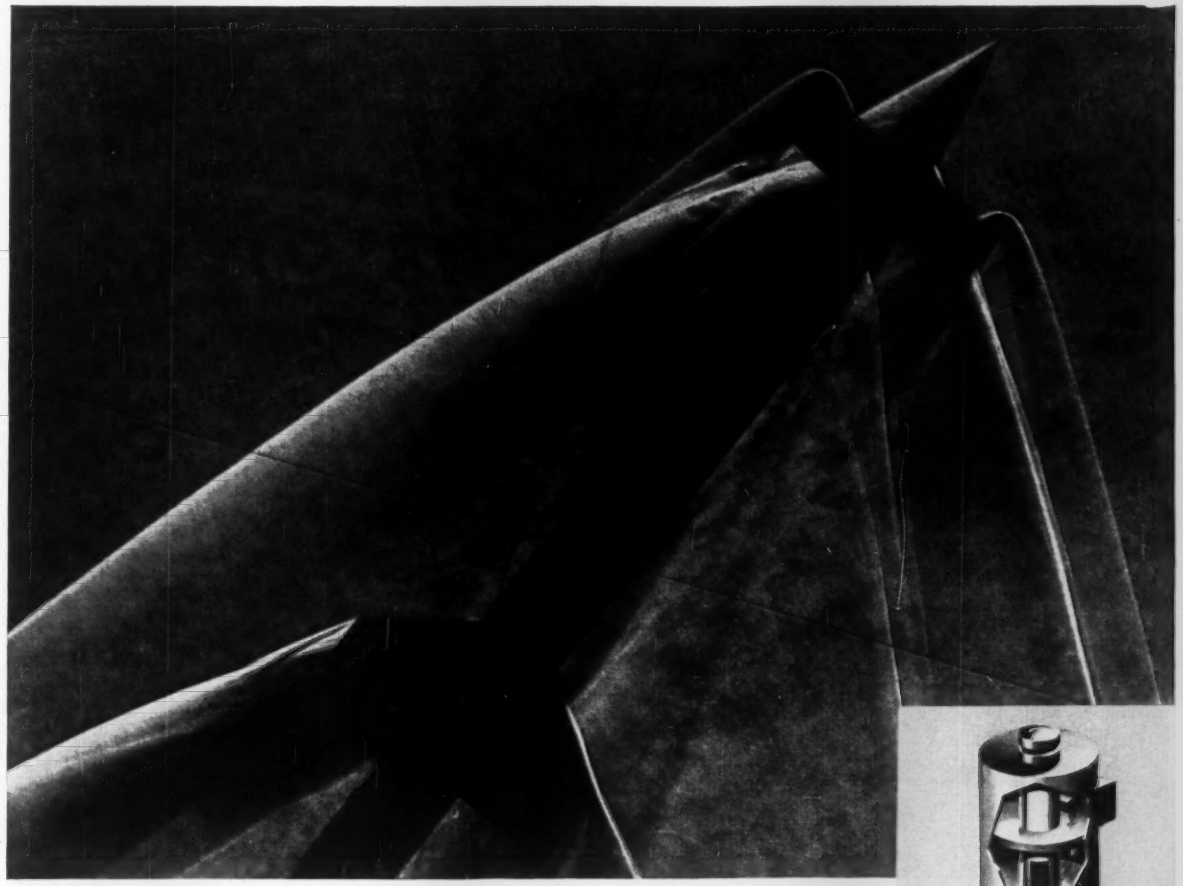
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



In the wind tunnel of the Naval Supersonic Laboratory at M.I.T., a missile model is subjected to speeds of several Mach numbers. B-L-H SR-4 bonded wire strain gages report longitudinal and latitudinal stresses, drag, lift, etc., with high accuracy.

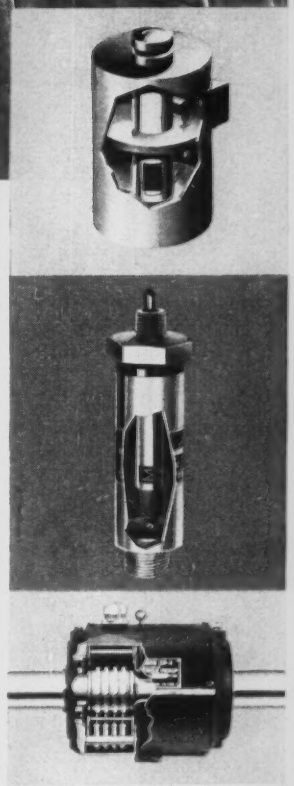
B-L-H ELECTRONIC TRANSDUCERS measure forces with new ease and accuracy

With the arrival of the Space Age have come increasingly severe demands on measuring instrumentation for precision and versatility. Accurate center of gravity computations, for example, are now more than important—they are vital.

B-L-H SR-4® transducers are highly responsive, durable and adaptable. Stock units offer long-term accuracy of ±1/10% and repeatability of ±1/20%. They will measure any forces involving tension or compression, torque, etc. With appropriate instrumentation, they can also determine center of gravity, weigh loads at rest or in motion, control batch and continuous processes, and record all data required. The type and number of applications are virtually unlimited.

The heart of every B-L-H transducer is its SR-4 bonded wire strain gages. They are bonded to a metal element in the transducer and approximately 10 milliamperes is fed through them. They receive the same strains as the transducer when a force is applied. Their electrical resistance changes in linear relationship with strain. The voltage output can be calibrated directly in terms of load—or fed into any common types of instrumentation, such as dial indicators, graphic recorders, digital printers, computers, etc.

For more information on SR-4 electronic transducers—load cells, pressure cells, or torque meters—ask to have a B-L-H man call on you—or write on your company letterhead for a copy of "Modern Force Measurement." Address Dept. 7E.



(top to bottom) Load cell, pressure cell, and torque meter transducers.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

Copyright 1959, E&I Div., B-L-H Corp.

For more information circle 74 on inquiry card.

Professional Personnel Requisition

Controls & Instrumentation Engineers

Marquardt Aircraft — a leader in air and space propulsion and control systems, high altitude rocket research and weapon support systems — offers a creative engineering environment in which you will find significant active projects. These include engine control systems for nuclear turbojet, inlet control systems for the North American F-108 and Hound Dog missile, control systems for the supersonic ramjet engine, feasibility studies of advanced and unique engine cycles, nozzle control for advanced ballistic missile components and other power system actuators. These control units include fluid and gas operated servo systems suited for environments above one thousand degrees.

If you are an engineer experienced in fluid dynamics or fluid operated controls and interested in mechanisms designed for severe environmental conditions, you should consider one of the following engineering opportunities at Marquardt:

CONTROLS DESIGN

To create components for pneumatic and hydraulic control systems. Work ranges from simple piston actuators to complex speed computing devices. All designed for high sensitivity, fast response, extreme environmental conditions and light weight. Should be experienced in machine design and have an understanding of basic design analysis.

CONTROLS ANALYSIS

To investigate aircraft and missile control problems through the application of analysis methods in mechanics and dynamics, heat transfer, compressible flow, and servomechanisms. Position offers opportunity for creative engineering.

CONTROLS DEVELOPMENT

Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

ENGINEERING STANDARDS

Implement, establish and/or originate the use of standards both design and hardware for reduction of time and cost of engineering effort. Must have knowledge of hydraulic and pneumatic design and components. Should be capable of setting up an evaluation program as required. Requires ability to work with many engineering groups both in advisory and service capacity.

CONTROL RELIABILITY

To predict reliability of control of units and recommend appropriate design changes. Knowledge of servomechanisms and feedback theory desirable. Should have background in statistics and experience in reliability field.

INSTRUMENTATION

Specification and design of instrument components and systems for ground testing of supersonic ramjet engines, jet engine components, inlet controls, nuclear powerplant controls and emergency power units. Prefer instrumentation experience, including data acquisition and processing equipment. Familiar with process control systems.

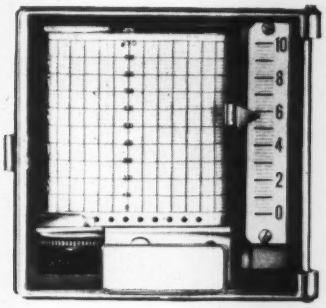
For additional information, please write
Mr. Floyd E. Hargiss, Manager
Professional Personnel, Dept. M-1
Marquardt Aircraft Co.
16555 Saticoy Street
Van Nuys, California

Marquardt AIRCRAFT CO.

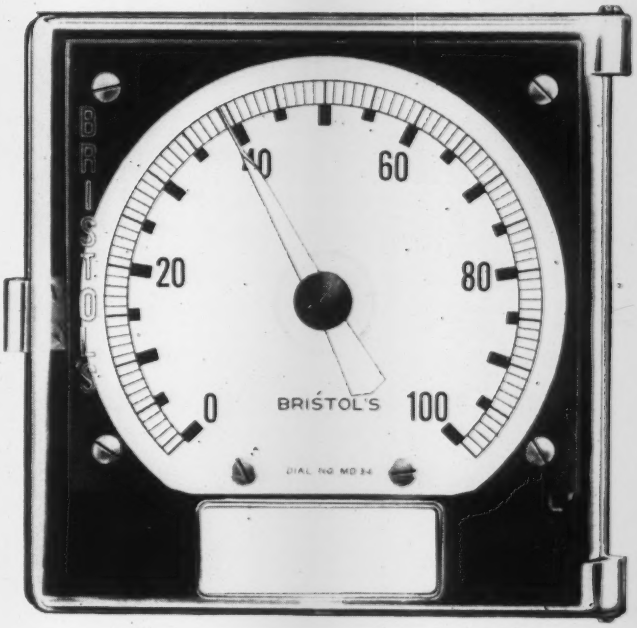
VAN NUYS AND POMONA, CALIFORNIA—OGDEN, UTAH

COOPER DEVELOPMENT CORP.—MONROVIA, CALIFORNIA—A MARQUARDT SUBSIDIARY

For more information circle **75** on inquiry card.



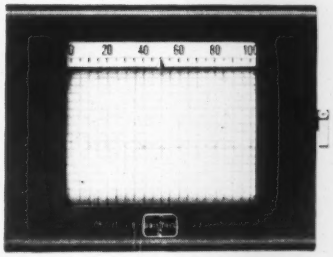
BRISTOL Indicating Electronic Dynamaster* Potentiometer and Bridge (shown below) has 8" effective scale length. Recording Electronic Dynamaster (left) has 3" chart. Panel sizes: Only 5" x 5⅛".



miniature electronic

POTENTIOMETER and BRIDGE INSTRUMENTS

for nuclear power and test reactors



Large-scale Dynamaster—11" chart.

The now-famous Shippingport, Pa., Atomic Power Station... The Bristol Company is one of the instrument suppliers.

More and more reactors are going on the line under Bristol measurement and control, and they're specified for many more under construction.

Miniature Bristol Electronic Dynamaster* Indicators and Recorders, furnished as either potentiometers or bridges, can measure any variable that can be transduced to an electrical quantity... **pressure, flow, temperature, liquid level, pH, and conductivity.** Already, in the nuclear industry as in hundreds of others, these high-precision miniature instruments are establishing an outstanding record for reliability, consistent performance, and utmost flexibility. Here are just a few reasons why:

FULL PLUG-IN FLEXIBILITY. You can interchange chassis in ten seconds... replace it with either recorder or indicator instruments... both plug in easily without tools. Chassis also pulls out to intermediate position for chart changing and inking without disconnecting from circuit. Easy range change, too.

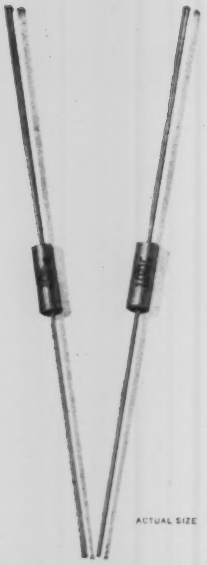
These features simplify planning of graphic control panels. Fifteen miniatures mount in less space than two full-sized units. The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut. 9.5

**T.M. Reg. U.S. Pat. Off.*

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **76** on inquiry card.



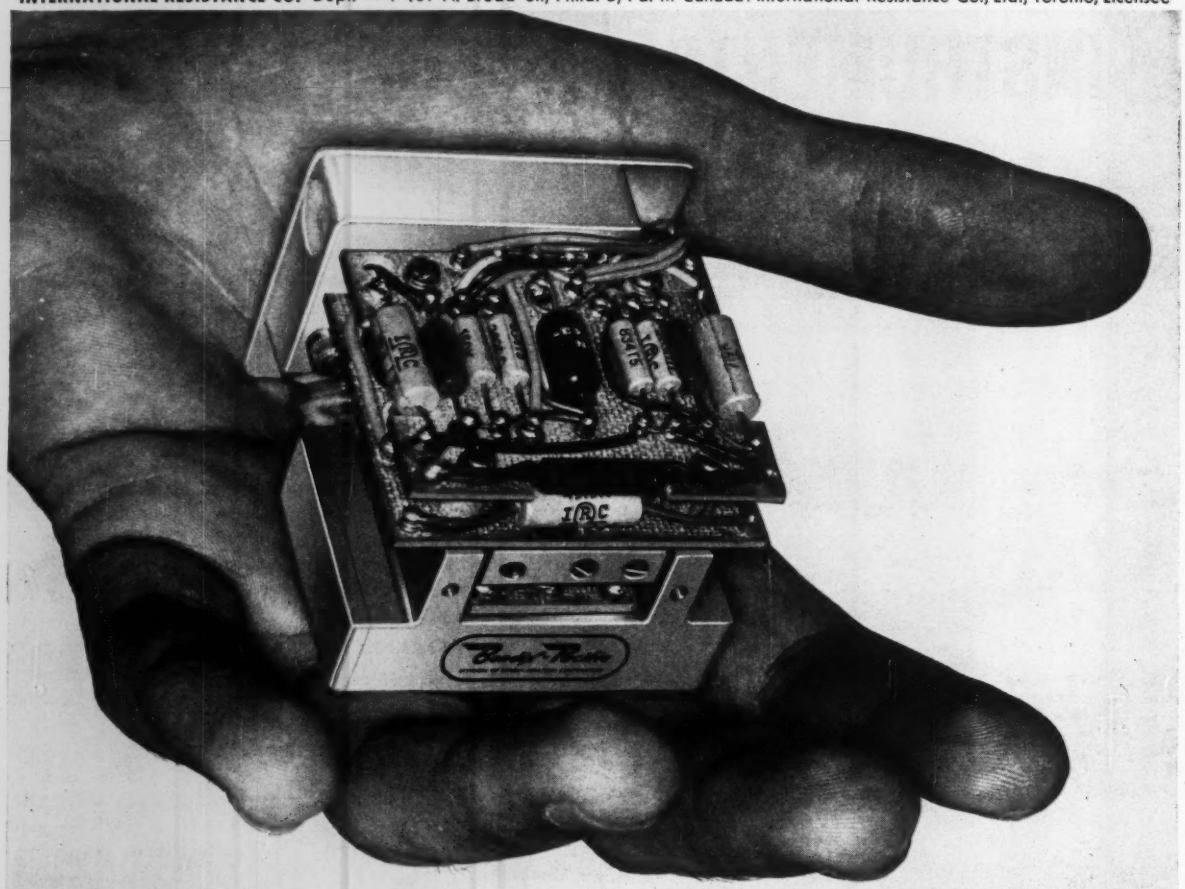
Small-World Resistors with out-of-this-world Reliability

Miniaturization is a severe test of performance, for reliability tends to shrink faster than size. Here, where critical equipment had to be made smaller, yet more reliable, Bendix-Pacific pinned performance to the reliability of IRC precision film resistors.

IRC Molded Metal Film Resistors combine excellent stability on load with a low, controlled temperature coefficient that is far superior to other precision film resistors. They exceed requirements for extremely close design tolerances and have excellent high frequency characteristics. Where these superior characteristics are not required, IRC Molded Deposited Carbon Resistors offer excellent all-around performance and economy. Both types available in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 watt sizes . . . and exceed MIL-R-10509B specifications. For design data, write for Bulletins B-3 and B-9.

IRC

INTERNATIONAL RESISTANCE CO. • Dept. 454, 401 N. Broad St., Phila. 8, Pa. *In Canada:* International Resistance Co., Ltd., Toronto, Licensee



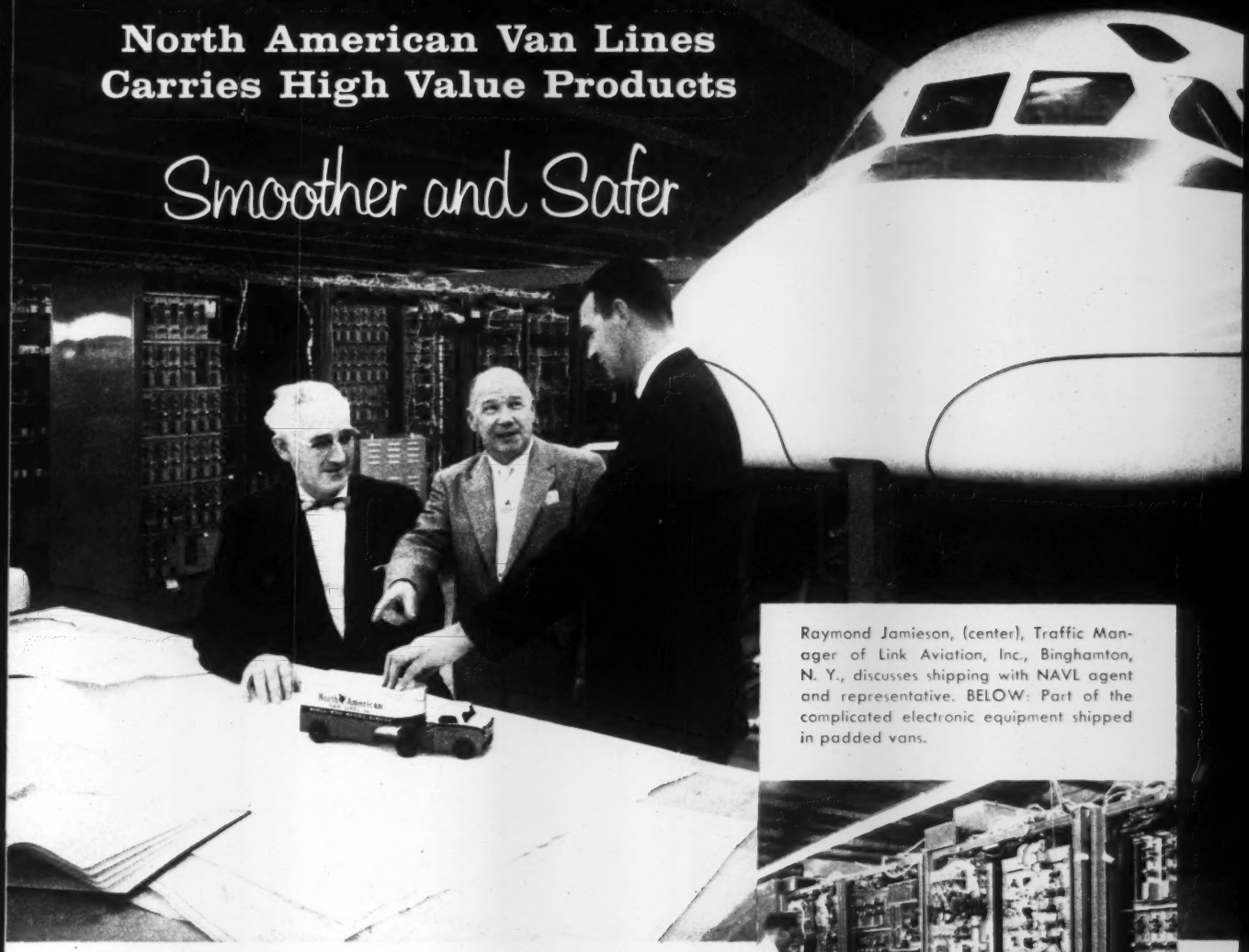
New Subcarrier Oscillator typical of integrated reliability and miniaturization achieved in telemetry equipment by Bendix-Pacific Division of Bendix Aviation Corp., North Hollywood, Cal.

For more information circle **77** on inquiry card.

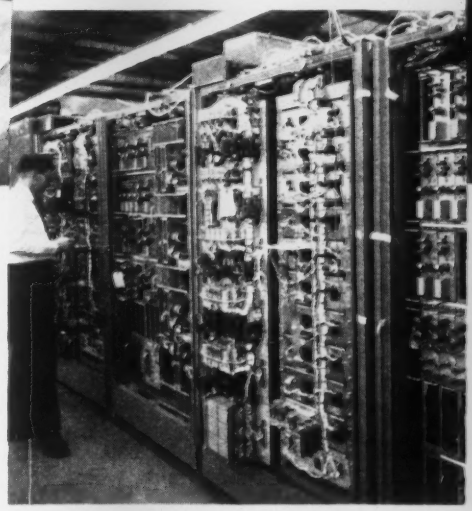
HERE'S PROOF:

North American Van Lines Carries High Value Products

Smoother and Safer



Raymond Jamieson, (center), Traffic Manager of Link Aviation, Inc., Binghamton, N. Y., discusses shipping with NAVL agent and representative. BELOW: Part of the complicated electronic equipment shipped in padded vans.



LINK AVIATION, INC. USES NORTH AMERICAN KID-GLOVE* CARE FOR SHIPPING FLIGHT SIMULATORS UNCRATED

"A $5,000 savings in cost in shipping by padded van over other methods is the bonus we get in delivering a typical flight simulator from Binghamton to the West Coast," says Mr. Jamieson. "With an insured actual value of up to $1,000,000, our primary concern is safe and careful handling. With North American Van Lines, we have never had a claim for damage."

*TRADEMARK

North American WORLD-WIDE MOVING LAND · SEA · AIR

See how you can save with North American service. Write, wire or phone today.

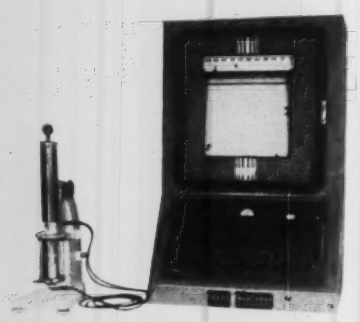
NORTH AMERICAN VAN LINES, Inc. / World Headquarters / Dept. 18-1 / Fort Wayne, Indiana

In Canada, North American Van Lines Canada, Ltd., Pickering, Ontario . . . in Europe, North American Van Lines Europe, GMBH, Mannheim, Germany

For more information circle 78 on inquiry card.

Speed your solution analysis

with these 4 modern laboratory "assistants"



Electro-Chemograph and Polarotron

Combination of both units provide a polarographic analysis with maximum speed and convenience.

Electro-Chemograph recorder provides:

• Continuously balanced current measurement • Complete shielding against pick-up • Operational arrangement of console controls • Eleven steps of current range from 1 to 100 microamperes • Three overlapping polarization ranges covering a span of +3 to −3 volts

Polarotron Dropping Mercury Electrode gives:

• Unmatched speed and convenience of sample transfer • Automatic mercury level control • Minimum mercury requirement . . . only 50 grams • Simplified temperature control of sample cell • Analysis of samples as small as 1 cc

For more information, ask for Data Sheet E-94(3).

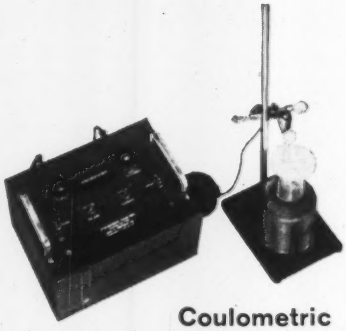
Portable Indicators for Electrolytic Conductivity

For the measurement of solution total ionic conductance . . . using a-c Wheatstone bridge circuit.

Features include:

• Wide range . . . two scales: specific conductance . . . 0.1 to 12,000 micromhos per cm^3, specific resistance . . . 80 to 10,000,000 micromhos per cm^3 • High accuracy . . . ±0.3% range • For use on grounded or ungrounded solutions • Adjustment for conductivity cell constant deviations

For more information ask for Data Sheet E-95(1).

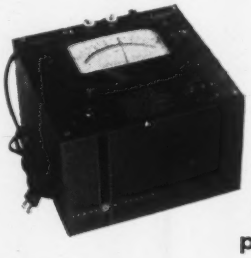


Coulometric Analyzer

Meets the need for rapid, highly accurate quantitative analysis in research by providing:

• Constant-current (±0.05%) coulometric titrations • Highly accurate titrant standardization • Direct digital read-out of micro-equivalent content • Versatile cell kit which speeds set-up time for titrations

For more information, ask for Data Sheet E-94(4).



Stabilized pH Indicator

Excellent performance of this instrument results from conversion of d-c electrode voltage to a-c signal, and a-c amplification.

Features include:

• Zero drift eliminated by a-c amplification • Unaffected by electrical pickup or normal variations in line voltage • Mirrored 5½ inch indicating scale of ±0.5% • Reproducibility ±0.02 pH; limit of error ±0.1 pH

For more information, ask for Data Sheet E-96(2).

LEEDS NORTHRUP
Instruments — Automatic Controls • Furnaces

4955 Stenton Ave., Philadelphia 44, Pa.

For more information on E-94(3) circle **79** on inquiry card.

For more information on E-95(1) circle **80** on inquiry card.

For more information on E-94(4) circle **81** on inquiry card.

For more information on E-96(2) circle **82** on inquiry card.

editorial

Needed: Non-Commercial Instruments

THE ANTI-HARDWARE philosophy of academic groups in the United States of America has been reported often in these pages. It has been shown how this philosophy works against the introduction of actual working (i.e., commercial) instruments into the classroom at any level. Yet a class equipped with working instruments is in a position to learn and assimilate modern technology much more rapidly than a class without such instruments.

How to resolve this dilemma?

The instrument industry could, through its various educational organizations, develop a class of inexpensive noncommercial instruments specially for educational purposes.

The inadequate funds available today for technical education are being devoted almost entirely to "academically pure" courses, with the result that many courses are now available in process dynamics. A line of working non-commercial instruments could prepare the math-science teachers of our nation better for these academically pure courses.

The Foundation For Instrument Education & Research could serve the instrument industry directly if it produced such a series of teaching aids that used noncommercial instruments to show the principles and practice of modern instrumentation.

Needed: Commercial Instruments

WE RECEIVE many inquiries from the field for instruments of various types. Most of these needs can be met by commercial equipment, but there are obviously many instrumentation needs that require *new* instruments.

Our readers are referred to the card on page 759. State your instrumentation needs and we will try either to meet them or to turn attention to them.

Dear D. R.*:

Every once in a while we use this personal letter to you for comments not dignified enough for a full "editorial." And speaking of editorials, have you ever noticed how vain editors are? Even when they only have some simple truism to say like "the instrument engineer must know components and systems and dynamics," or "instruments are used in systems," they use type that is twice as big as regular type. Unfortunately, there is no direct relation between the size of an idea and the size of the type used to print it.

Also, have you noticed that the articles in *INSTRUMENTS & CONTROL SYSTEMS* have been parts of series designed to survey an entire field of instrumentation? For example, there is one article on magnetic tape in this issue—but you received previously the following articles on tape:

- Magnetic Tape Recorders
- Tape Recording Techniques
- Digital Tape Recorders
- Magnetic Tape Dropouts
- Tape System for Analog, FM and PDM
- Digital Recording Magnetic Heads
- Magnetic Tape Terminology

And you will get the following in this and succeeding issues:

- Magnetic Tape Equipments Survey
- Magnetic Tape Systems Applications
- Magnetic Tape IRIG Standards
- Magnetic Tape FM/FM Standards
- Magnetic Tape FM/PDM Standards
- Wow and Flutter Compensation
- Maintaining Magnetic Tape Files

There is another field being covered for you at present—motion, including displacement, velocity, acceleration, and vibration. So far you received:

- Fundamentals of Restrained Motion
- Vibration Often Requires Displacement Measurement
- Velocity Pickups
- Accelerometers
- Accelerometer Calibration
- Vibration Meters
- Vibration Seismographs and Vibraswitches

And here are the articles you are going to get:

- Acoustic Sensitivity of Accelerometers
- Measurement of Bearing Vibration
- Electrodynamic Standards for Vibration Pickups
- Acceleration Generators
- Seismometry Technique
- Seismometers

So you see that an article in *INSTRUMENTS* is usually much more than just another article. Hope this finds you happy and (reading) well.

Milt

*Dear Reader

Digital Printers

FIG. 1. AT&T communications system.

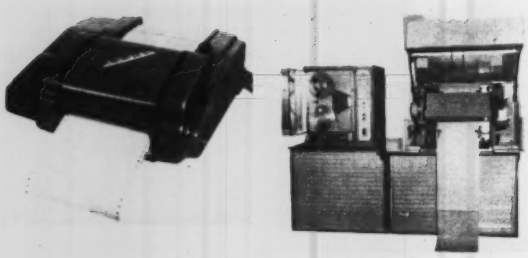


FIG. 2. ANELEX high-speed printers.

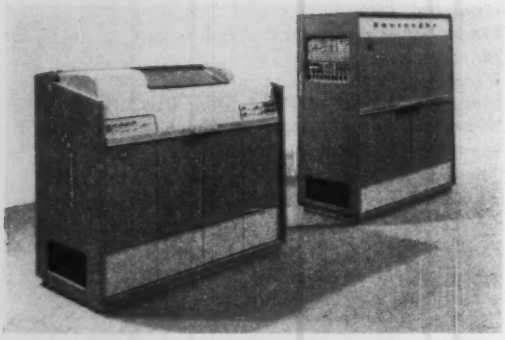


FIG. 3. BURROUGHS ElectroData high-speed printer.

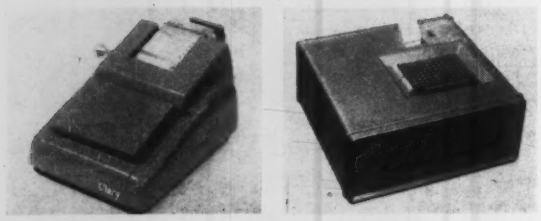


FIG. 4. CLARY printers include form printer (left) and scanning printer (right).

DIGITAL PRINTERS range from solenoid-actuated desk-top adding machines to large, high-speed, electronic-image devices that can operate in-line with fast computers, printing out at a rate of 100,000 words per minute. This review of digital printers reveals the large range of abilities available.

American Telephone and Telegraph

AT&T provides a communication service with transmitting and receiving typing reperforators that can link distant offices and plants (Fig. 1). Standard equipment provides 5-channel Baudot-code tape at printing speed of 60, 75 or 100 words/minute, 5 characters and one space per word. Paper receiving equipment handles marginally-punched multicopy forms; 8 copies can be received on one transmission, depending on grade of paper.

Anelex

Anelex offers high-speed printers using wheel-type on-the-fly printing (thyratron drive) at speeds up to 2000 lines/minute (5280 characters/sec). Data can be received from computer or tape. Prints one full line at a time.

Printer can be tied into most existing computers; complete magnetic tape to printer system is available. Maximum form is 20″ wide, 22″ long.

Family includes small 24-column desk-type to large 160-column models (Fig. 2).

Burroughs

The Burroughs ElectroData 220 high-speed printer system (Fig. 3) selects, edits and prints out copy direct from a Burroughs 220 computer or from magnetic tape at rates above 20 alphanumeric and 25 numeric lines per second. When integrated with the Burroughs 220 electronic data processing system, the printer's features include on-line or off-line operation, buffer data storage and automatic editing under plugboard control. Its vocabulary consists of 51 solid-face characters printed in lines of 120 positions each.

The 1100-digit memory buffer allows simultaneous data loading and final printing. The plugboard allows the operator to program-control the printer independently of the computer. Control over final printing format includes line spacing, skipping and other versatile paper movement functions. Maximum form width is 20″, length is 22″.

Clary

Clary offers a large line of solenoid-operated printers, with printing speeds of up to 3 lines/second, 12 digits/line (Fig. 4).

A survey of commercially available printers

Three standard "P" series parallel-entry printers are offered for off-the-shelf delivery with a choice of over 100 special dials, choice of punctuation and optional zero-suppression logic. The standard "P" series includes: Model P-5—five decades of input capacity; Model P-8—eight decades; Model P-11—eleven decades. Printing speed is 2½ lines per second with red and black print color selectable electrically.

The 1900 series parallel-entry numerical data printers of Clary consist of six basic models capable of adding, subtracting, totalizing and printing.

A new scanning printer makes the digital selection during the printing cycle. It will operate from decimal contact closures or from binary-coded decimal logic. This enables the same printer to alternately print out information from stepping switches, digital voltmeters or electrical input keyboards as well as electronic computers, EPUT meters and binary-coded shaft-position transducers. It will print more than 3 lines per second, 12 digits per line.

Standard data printers are available in combination with the Model 701 tape perforator, for any tape code from 5 to 8 channels.

Computer Measurements

Model 400C (Fig. 5) prints a 6-digit line at 4 lines per second, and has these optional features:

1. Ten-line output from each digit for operating card and tape punches and electric typewriters. The output can be used with either serial- or parallel-entry devices.
2. Analog output for driving graphic recorders; standard output is 1 ma.
3. In-line readout for visual monitoring with either 2¼"-high digit, or Nixie tube.
4. Accumulator for final totalizing or totalizing results over a period of time.
5. Code conversion to accept 1-2-4-8 or other codes.
6. A transistorized drive which accepts low-voltage input. Matrixes can be driven directly without any intermediate stage or buffer.
7. An add-subtract solenoid which will print plus numbers and minus numbers on command.
8. Print-line identification for coding any desired line of numbers.

Electronic Associates

The 39.034 printed (Fig. 6) will print the output of the company's 26.070 digital voltmeter at rates of up to 4 lines per second. The 11 columns available give 2-digit address, sign, 4-digit reading, and floating decimal. A typical reading appears as follows: 32 + 1 0.8 9 indicates that input 32 reads + 10.89 volts.

The modes of operation include, manual, semi-automatic, and automatic. Input levels are −9V (±1V) to inhibit, 0 to −3V to print. Input impedance is 1600 ohms.

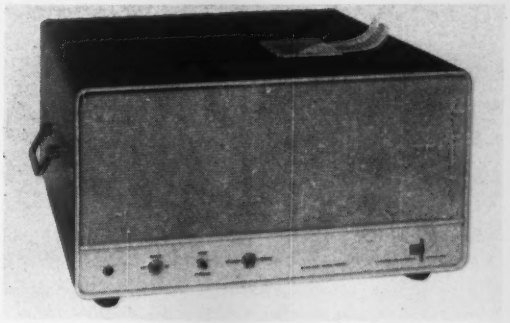


FIG. 5. CMC printer has matrix circuitry.

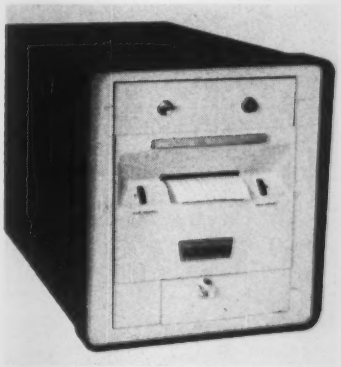


FIG. 6. PACE printer for use with EAI digital voltmeter.

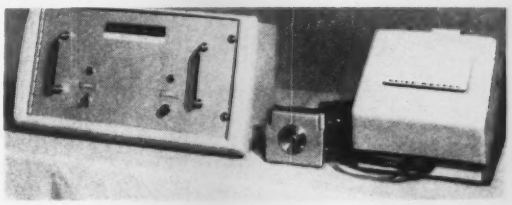


FIG. 7. DATEX line includes printers operated from shaft digitalizer.

Datex

The K-120 system (Fig. 7) provides automatic or on-demand digital recording on adding-machine tape from a shaft input, or from many types of standard recorders. The K-120 system uses a C-100A shaft-position-to-digital encoder, a K-120 control chassis, and a Datex-Monroe printer. No gearing is necessary between the encoder and instrument drive, and installation of the encoder will not affect the performance, response or accuracy of the recorder. The

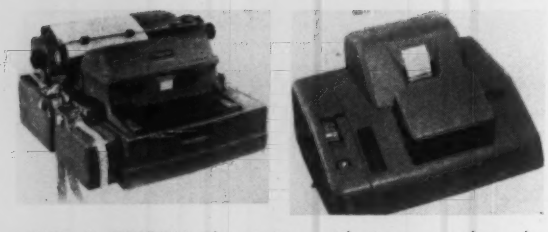


FIG. 8. FRIDEN Flexowriter with tape punch and tape reader; right shows Add-Punch adding machine with tape punch.

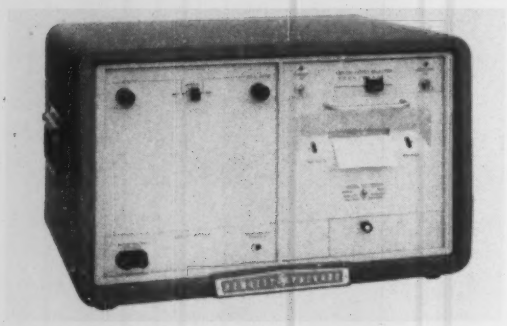


FIG. 9. H-P Model 560A digital recorder.

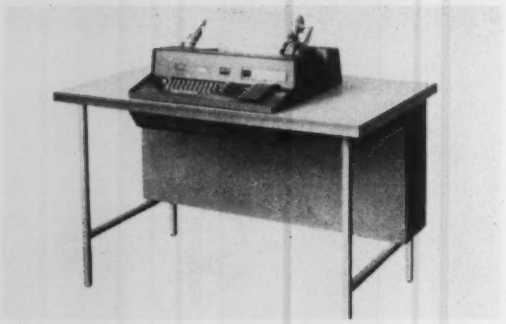


FIG. 10. IBM printing station for use with 305 RAMAC.

three-decimal-digit, parallel-entry, electric printer is a basic Monroe office machine with an electric actuating mechanism developed by Datex. Other printers enter up to fourteen digits simultaneously, can accumulate, and operate integral tape punch.

Maximum printing speed is two recordings per second.

Friden

Friden offers printers with maximum printing speed of 10 characters per second.

The *Flexowriter* (Fig. 8) is an automatic writing machine which provides for unattended preparation of letters and other documents. It punches a tape automatically as a by-product of an original operation. Afterwards, the tape can activate the machine at a reproduction rate of over 100 words per minute, eliminating manual typing.

The *Justowriter* prepares justified (even-margin) copy for printing or duplicating.

The *Computyper* delivers complete invoices at the rate of 10 digits per second. Typist-operator need enter only such variable data as quantities ordered. The Computyper automatically types repetitive data, headings, items, item codes, etc., and figures extensions, additions, deductions and totals automatically. Model A Computyper links a desk calculator with an electric typewriter.

Model ABS adding and listing machine operates automatically and unattended by electric pulses which can be created as a by-product of the operation of many machines. The numeral solenoids are capable of accepting data at speeds of up to 1,200 digits per minute (20 per second).

The Friden Model APTS add-punch (Fig. 8) is designed for automatic operation. Input, both numerical and control, is by electric pulses.

The Model ABS remote adding and listing machine also operates automatically by solenoid.

Hewlett-Packard

Models 560A and 561B digital recorders (Fig. 9) automatically print up to 11 columns of data on adding-machine tape at a rate up to five 11-column prints per second. Several sources can operate the digital recorders simultaneously, or information can be fed in sequentially by switching between sources. Model 560A also provides an analog voltage or current proportional to the digits in any selected three-column set. By selecting the analog proportional to the last three digits of an 8 digit signal, a strip chart record will have full-scale values of 1 part in 10^5 and resolution of 1 part in 10^8. Since the value of each analog column is independently determined, this zero suppression action is essentially error-free and the chart record always remains on scale.

Model 560A operates from any "staircase" source such as modified electronic counters, digital voltmeters, and stepping-switch voltage-dividers. The symbol that is printed in a given column is determined by the voltage level present at its input terminal at the time a "print command" pulse is received.

Up to 12 wires, one for each symbol, are available for each of the 11 data columns. A given symbol is programmed by connecting one of the 12 symbol wires to a voltage source or common terminal prior to the print command. The print can be initiated by either a contact closure or a negative pulse.

Ten-line sources such as electronic counters, digital voltmeters, stepping switches, and beam switching tubes will operate the 561B directly. Maximum print speed is 5 lines per second.

The Model 405AR, a low-price printing digital voltmeter, reads d-c voltages from 100 millivolts to 1000 volts in three significant figures. Decimal point and polarity sign are automatically positioned and 10-line, 4-line and staircase output codes are presented with each reading. As the 405AR uses a "ramp" type of analog/digital conversion, its sample rate may be varied up to 5 per second.

IBM

The IBM 381 Remote Printing Station is shown in Fig. 8. Up to four 381 stations can be attached to an IBM 305 RAMAC data processing system to provide remote typing output. Output data can be typed on one or any combination of the remote printing stations, as well as on the typewriter at the operator's console.

Maximum printing speed is 10 characters per second. A high-speed printer using a parallel printing technique is available for printing speeds of more than two 120-character lines per second.

The IBM automatic electric typewriter has a speed of 10 characters per second.

Kleinschmidt

Kleinschmidt offers complete commercial and private printed communications systems, including the Model 150 teleprinter (Fig. 11) and the high-speed Model 150 teleprinter and the high-speed Model 195 typing reperforator. Systems operate with standard 5-unit start-stop Baudot code, and units can be interconnected via line, radio or microwave carrier systems.

The Model 150 receives 60 to 115 words/minute (up to 690 characters/minute). Features include neutral or polar operation on 60 ma dc signals when terminals are connected to telegraph line, 20 or 60 ma dc signal when connected to carrier systems through local circuit. Provides up to 6 copies, 72 characters/line.

Model 195 typing reperforator punches a tape and types simultaneously at rates to 750 words/minute.

FIG. 11. KLEINSCHMIDT Model 150 page printer.

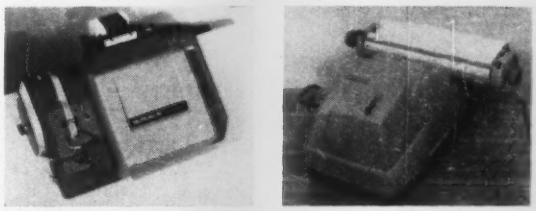


FIG. 12. MONROE printers include MC-205 (left) and MC-215.

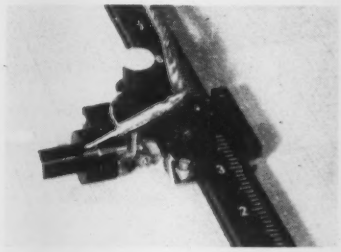


FIG. 13. MOSELEY character printer for Autograf x-y recorder.

Monroe Calculating Machine

The Series MC-205 Data/Log (Fig. 12) is an electric parallel-entry printer, available with or without the ability to accumulate. The unit can be operated with or without the tape punching function, upon external command. Maximum speed of complete machine cycling (10 digits per cycle) is from 180 per minute for printing only, to 64 per minute for printing, accumulating, and punching. MC202 is similar, but without tape punch.

Series MC-203 makes possible entry of up to fourteen digits simultaneously; paper width is 18"; carriage is indexed automatically.

Latest addition to line is Model MC-215, a serial entry machine having multiple accumulators and a tabulating carriage.

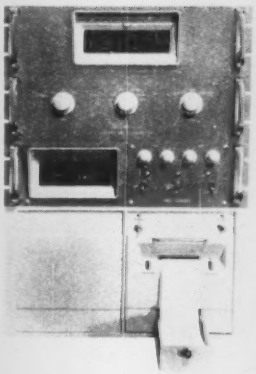


FIG. 14. NON-LINEAR SYSTEMS printout for digital voltmeter.

Moseley

A character printer has been designed specifically for use with the Model 2A Autograf x-y Recorder to identify curves obtained from plotting digital information. The character printer assembly (Fig. 13) is installed on the carriage of the recorder in the position usually occupied by the liquid ink pen, but does not exclude use of the pen when desired. The Type D-2 Character Printer consists of a character wheel having six inscribed symbols equally spaced around its periphery, a ratchet and pawl mechanism for sequentially indexing successive characters, and a solenoid to actuate the printer operation and to index the subsequent symbol. Type D-3 includes a remote control feature permitting external manual symbol selection or automatic programming of symbols directly from IBM cards or perforated tape. Print speed is 1 point/sec nominal, 3/second maximum.

Non-Linear Systems

Model 155 (Fig. 14) is a transistorized printer that automatically records digital instrument output when plugged directly into the digital output connector at the rear of each Model 20 Series transistorized digital voltmeter. Model 155 records in 0.2 second, which is inside the Model 20 Series measurement time of 0.3 second.

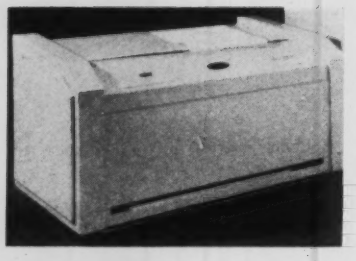
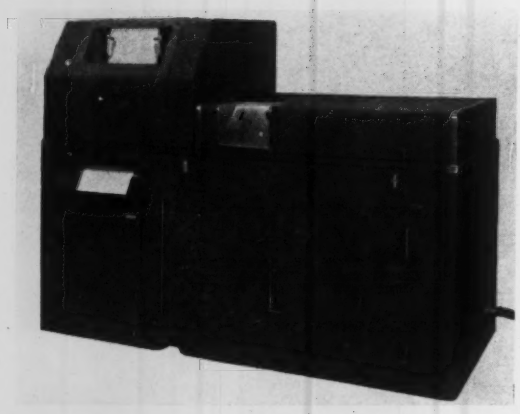


FIG. 15. PANELLIT 607 and 609 information and computing systems use this printer.



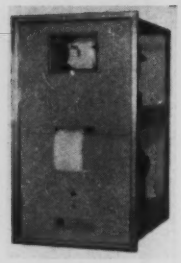


FIG. 16. POTTER printers include 1200 character/second Magnityper (top) and 400 character/second alphanumeric Model 3260.

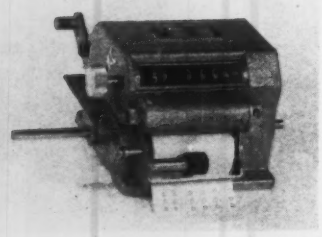


FIG. 17. PRESIN printing counter.

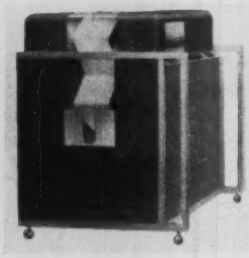


FIG. 18. RCA printer for 501 EDP system.

Printing is initiated by a —28-volt 10-ms pulse, or by external momentary contact closure. Will also operate from NLS stepping-switch-type digital voltmeters, ratiometer and ohmmeters.

The printing mechanism used is an adaptation of the Hewlett-Packard Model 561A printer.

Panellit

The standard 607 Dual Function Information System (Fig. 15) employs a segmental log chart for recording periodic and demand logs, twenty-four hour logs, and off-normal logs and summaries. Up to 225 information points can be recorded on one log chart (a Panellit patent), which contains a description of each operating variable. Maximum printing speed with system is 75 words (300 characters) per minute.

Potter Instrument

The Magnityper (Fig. 16) is a high-speed electronic printer consisting of two major assemblies: the printing mechanism and the storage-comparator system. Speed is 1200 characters per second.

The printing mechanism consists of a horizontally mounted drum on which are mounted up to 120 columns of type, in units of 20, with 63 distinct characters in each column. A programming wheel is mounted on the shaft of the drum. The drum is motor driven, presenting each character for each column to its associated solenoid-controlled hammer. An inked ribbon and paper moves between the hammers and the type faces. Printing occurs when the solenoids actuate the hammers, pressing the paper against the selected character in each column as the drum rotates. The sprocket-driven paper advances upward in a predetermined vertical format during the interval between lines, under control of a perforated tape loop.

A Magnistor memory system (magnetic logical gating element of 120 six-bit modules) permits digital information from the input source to be stored sequentially. Information stored in the memory is read out by comparison of the memory elements to the interrogation elements. The output of a module fires the hammer when the appropriate character is in position. Print rate is approximately 10 120-character lines per second.

The Model 3260 alphanumeric high-speed digital printer (Fig. 16) has speed of more than 400 digits or characters per second. The unit can be connected directly to most data producing devices with little modification. It can be supplied with up to 40 columns of numeric or alphanumeric characters and is capable of printing at speeds of 20 lines per second for numercial applications, and 10 lines per second for alphanumeric applications. Up to 63 characters are available, including alphabetical, numerical, and special symbols in any desired combination.

Presin

New Model U 271S printing counter (Fig. 17), driven by servo or synchro motors from shaft input, has counting rate of 5,000/minute, either adding or

subtracting. Maximum complement of digits is 7 (non-resettable), or 6 if reset is required. Printing can be on tape or card at max print rate of 1 per second.

Also available is Model ZDG, with parallel entry to 14 digits, with individual access to each.

RCA

The 501 Electronic Data Processing System incorporates an on-line printer (Fig. 18). Information to be printed is delivered directly from the computer to the printer. The printing format is controlled by the computer, either directly or through a punched-tape loop in the printer unit. The printer prints characters on continuous edge-perforated (blank or preprinted) paper forms as instructed by the computer. Speed is 10 lines per second, 120 characters per line. Vertical tab rate is 50 lines per second.

Remington Rand

The high-speed printer shown in Fig. 19 operates at speeds up to 10 lines per second, 130 characters per line. A special fast-feed feature advances the paper rapidly over areas where no printing is required. As a result, 7,500 paychecks can be printed in less than an hour.

The printer has a continuously revolving shaft on which are 130 typewheels (actually 65 double wheels). Opposite each typewheel is a hammer. The paper, together with an inked ribbon or special carbon paper, passes between the hammers and the typewheels. A hammer, when energized, drives the paper against the typewheel printing the opposed character on the paper.

Mounted on the same revolving shaft holding the typewheels is a commutator and photoelectric cell circuit which generate the pulse code of the character that has just entered the printing position. This code is sent to a 120-place comparator which also receives, in the same code, the contents of the 120-place memory which was filled by information read from the Univac tape. When agreement occurs, which may be in many places of the comparator at once, signals leave those places on separate wires and release the energy which drives the hammers against the typewheel.

Research Appliance

The RAC Digital Recorder (Fig. 20) is an automatic self-balancing, null-type analog-to-digital indicator, recorder, and controller. A high gain amplifier detects the voltage unbalance in the bridge or potentiometer circuit and amplifies this voltage sufficiently to drive the balancing motor. The digital indicator consists of six digits.

Zero to full-scale response time of the standard instrument is 3 seconds. The printing cycle may be externally controlled either automatically or manually.

Royson

"Identichart" prints numerical data along the edge of charts. The Identichart normally is mounted on a strip chart recorder and the printed data used to speed trace interpretation and analysis. The unit can

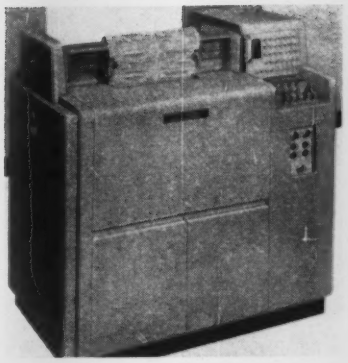


FIG. 19. UNIVAC high-speed printer.

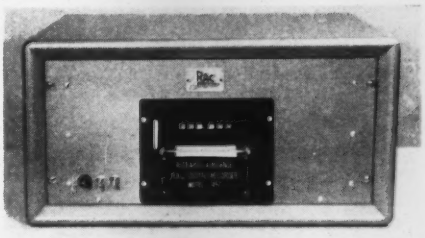
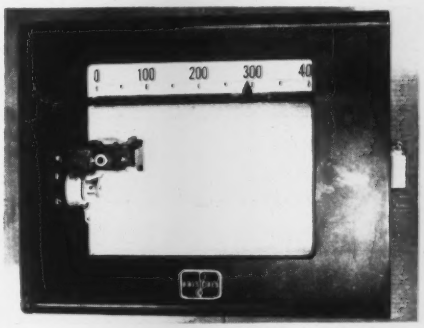


FIG. 20. RAC 457 is analog-digital converter-printer.



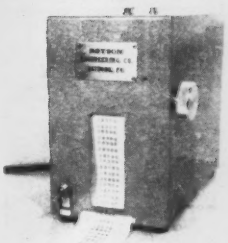


FIG. 21. ROYSON Identichart on Bristol recorder and printing counter (right).

be operated by remote control, or automatically.

Many models are available printing time, date, identification, etc. Counting rate of counting-type printers is 500 counts/minute; printing speed is 4 impressions/second.

Also offered is a tape-printing counter (Fig. 21) with a counting speed of 500 counts/minute; printing speed of 5 impressions/second.

Shepard Labs

High-speed TYPER (Fig. 22) is an electronically operated printer capable of 1800 characters per second. Input can be direct from any computer via a magnetic

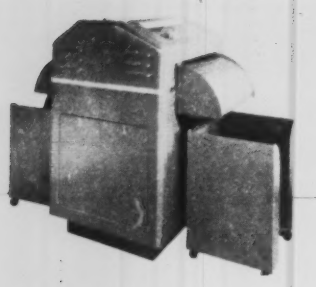


FIG. 22. SHEPARD Model 190 high-speed typer.

FIG. 23. SOROBAN Automatic electric typewriter.

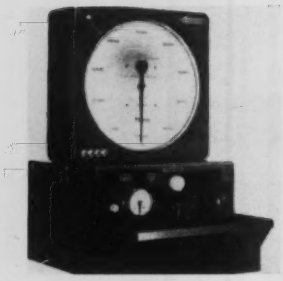


FIG. 24. AMETRON printing scale.

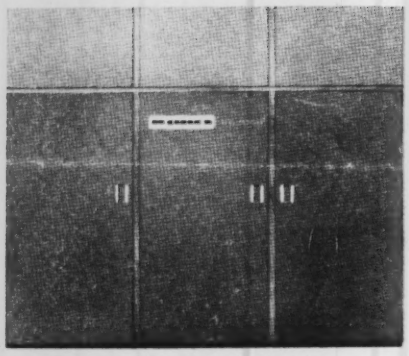


FIG. 25. STROMBERG-CARLSON S-C 5200 high-speed printer.

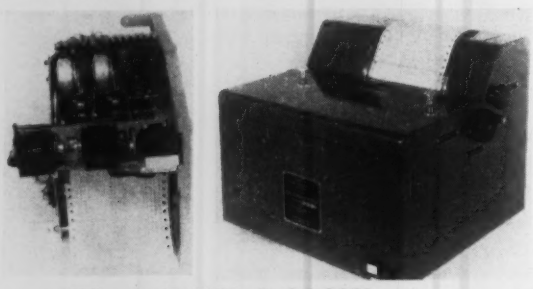


FIG. 26. TALLER & COOPER printers.

tape; output is on prepunched folded forms. A Shepard high-speed variable-speed servo tape transport may be used between computer and printer to eliminate cost of a buffer memory. Its decoder accepts conventional Teletype or Flexowriter pulse information.

Model 190 is drum type and prints up to 190 columns in width. Drum periphery has up to 64 characters per column.

Also available is a smaller MINITYPER using same principle, with horizontal spacing of 5 to inch rather than 10 to inch. Speed is 10 lines/second, 14 to 48 columns; max printing rate is 480 characters/second.

Soroban Engineering

Soroban offers a line of Computeriters, which are IBM electric typewriters (42-key Model B) with modifications for automatic operation with coding and decoding mechanisms. Speed is 10 characters per second. Models are available for typing from coded input signals or developing coded output signals from manual keyboard entries (Fig. 23).

Streeter-Amet

The Ametron printing scale is shown in Fig. 24. A series of step cams receive rotational information from a self-balancing servo motor (that can null output from strain-gage load cells). The step cams rotate until they are positioned proportional to the weight on the scale. When a print is desired a set of mechanical sensing fingers move to the step cams to detect the value of the weight. Each finger moves a rack that meshes with the pinion of a typewheel which rotates a corresponding amount. After all typewheels are positioned, a print hammer snaps down to print the weight from the typewheels. Maximum printing speed is 1 impression per second.

Stromberg Carlson

Stromberg Carlson offers a line of electronic high-speed printers. Combining the Charactron shaped-beam tube with xerographic printing technique, printing is performed without impact on untreated paper of any weight, including lithographic masters. Model S-C 3000 has a speed of better than 10,000 words per minute; Model S-C 5000 has speed of more than 100,000 words per minute.

Newest of the S-C 5000 Series High-Speed Electronic Printers is the S-C 5200 Registration Printers (Fig. 25) specially designed for commercial applications requiring close tolerance registration of computer data on pre-printed forms. Printing up to 5,000 lines per minute, printer provides economy in large-volume processing of statements, records, etc.

Also offered is a line of high-speed microfilm printers, using the Charactron to print directly on microfilm at speeds to 15,000 characters per second. Data can be seen on direct-view screen less than 10 seconds after exposure.

Taller & Cooper

Taller & Cooper offers a wide line of electromechanical printers (Fig. 26) with speeds to 3 lines/second, 9 digits/line.

Inputs include pulse input, analog input, digital

input, or combination input. Any such input can be read directly as an output, in any printed form.

Output forms available include alphabetical, numerical, or any combination of both (alphanumeric). Special arithmetic progresssions to any base also can be supplied, such as the duodecimal system, which counts against a base 12. These units permit direct readout of measurements in feet and inches, pounds and ounces, etc. Printers have an optional, automatic ribbon shift to allow printing in red to flag dangerous or off-line conditions.

Teletype Corporation

Teletype offers a line of electromechanical printers of dependability proved by many years of service in commercial telegraphy, press and communication networks, stock-market quotations systems, etc. Printing speeds are available up to 100 words/minute.

The line includes composite page-tape sets, as well as printers tailored for special applications, such as military. Fig. 27 shows two standard Model 28 units, the send-receive page printers (left) and composite set (right) with tape and control facilities.

The Teletype Model 28 operates with 5-level Baudot code at a printing speed of 10 characters per second. Signal requirement is 20 or 60 ma d-c line current. Features include quickly interchangeable type boxes, special switching and control features, either friction or sprocket feed of printed form or paper, horizontal tabulation, and automatic carriage return. It also can accommodate parallel-wire input. The Teletype Model 28 was chosen as one of printer available with the new Burroughs ElectroData 220 EDP system.

Accessory tape punches and readers are available.

Telechrome

Under development by Telechrome is an industrial printer designed especially for printing in industrial (mill-floor) environments.

Underwood

The Data-Flo Servotyper (Fig. 28) looks like a regular Underwood Electric. Beneath the keyboard are solenoids which operate the machine automatically at speeds up to 11 characters per second. The machine can be operated manually when it is not being operated automatically. Actuating devices include quantizers, digital converters, diode matrices, and transducers with digital outputs. Actuator solenoids operate on 100 volts, 100 milliamperes, dc.

Veeder-Root

Veeder-Root offers several counters with printing registers. Unit in Fig. 29 is reset ratchet counter with printing register, with counting or printing speed to 1000 cpm. Printing counters are available for many applications, as on flowmeters that print total flow into tank.

Victor Adding Machine

Both the parallel-entry and serial-entry Digit-matics (Fig. 30) use a printing-press action which moves the paper to meet the type, instead of the common hammer-fired system. Printing-press action reduces wear, vibration and noise and saves up to 45 parts for each column of machine capacity.

Many modifications can be made to accomplish specific results. One or two extra copies of the printed tape can be made by a special non-smearing chemically-coated "carbon" paper. Zero eliminators automatically suppress the printing of zeros to the left of the most significant figure. Parallel-entry models can add and subtract degrees, minutes, seconds, and thousandths of seconds. Thousandths of seconds automatically convert into seconds, seconds into minutes, and minutes into degrees. Parallel-entry machines can be equipped to handle whole numbers and fractions simultaneously. Machine may have a plain cover over the solenoid assembly or keybuttons for direct entry.

Can be furnished with 4 solenoids—125 to 160 v dc, 42 to 52 v dc, 21 to 28 v dc, 105-125 v ac. Solenoid operating time is 20 ms on-time, 30-ms off-time. Printing speed for serial-entry machine is 1 line/second for 10-digit entry; printing speed for full-key is 2 lines per second with accumulator, or 3 lines per second without accumulator.

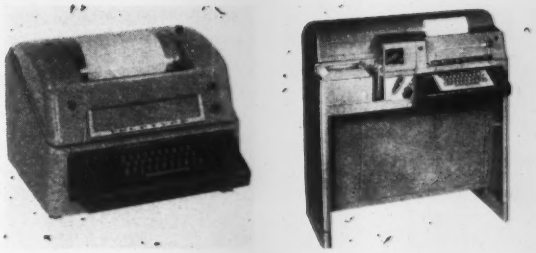


FIG. 27. TELETYPE Models 28.

FIG. 28. UNDERWOOD Servotyper.

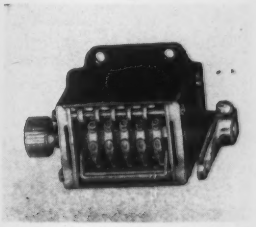


FIG. 29. VEEDER-ROOT counter with printing register.

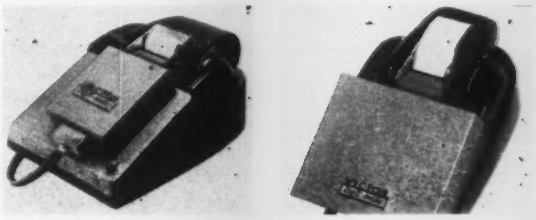


FIG. 30. VICTOR serial (left) and parallel-entry Digit-matics.

Fig. 1. Form printer.

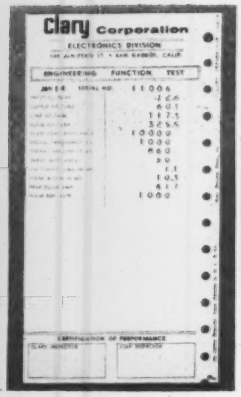


Fig. 2. Typical form

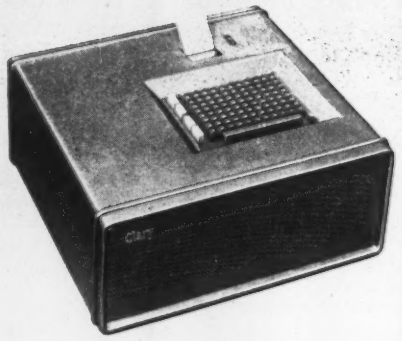


Fig. 3. Scanning printer.

TAPE PRINTER APPLICATIONS

Incorporating solenoid actuators and an output commutator in a standard adding-machine printer results in a low-cost data link with wide applications. Many types and variations are available.

WILLIAM R. BEALL
Clary Corporation

USE OF TAPE PRINTERS for recording the outputs of electronic equipment had its modest beginning in the year 1950. The specifications established by early users were: (1) the printer should be capable of printing at least three digits per line, (2) the printing rate should be one line per second, (3) the electrical inputs should be in decimal form, and (4) the printers should be inexpensive.

By apply solenoids to existing adding machines, the result was that digital recorders were made available to industry without a prolonged development period. Standard adding-machine components accounted for approximately 85% of the digital printer; as adding machines were tooled for mass production. digital printers of this type were relatively inexpensive.

By 1953 the demand for test data on electronic circuits and components increased steadily. The volume and the accuracy of the data required dictated the use of digital instruments associated with a tape printer.

From 1954 through 1957 electrically controlled tape printers were associated with all types of electronic equipment, such as digital voltmeters, electronic counters, digital clocks, EPUT meters, shaft position transducers, step-switch banks, relays and computers.

More recently, tape printers have been integrated into large test units comprising several of the above mentioned instruments together with a master programmer. Such "checkout systems" are used to analyze complex electronic and electromechanical systems such as missile guidance and control systems.

Tape printers generally produce recorded information on a paper tape 2¼" in width and in any length. An original, plus two or three copies may be produced at one time by the use of compatible paper, a copy-producing process which operates on the principle of chemical action between adjacent sheets of paper under the pressure created by the printing impact.

Form Printer

Some data-logging requirements require a printing capacity of 12 digits per line for test data. Use of a preprinted form (Fig. 1) permits all 12 digits to be used for data.

The Form Printer was developed to meet these two requirements, and produces standard forms measuring 3½" in width by 7" in length. This width provides adequate space for preprinting information relating to a given line of recorded data.

The form printers also can print on adhesive-backed labels because of its positive registering ability.

One of the advantages of "adding-machine" tape printers is that the arithmetic operations available in the adding machine can be used. A series of readings recorded by the printer can be added and then the total recorded. When data comprises both positive and negative magnitudes, the net algebraic value is printed.

For example, in a weighing application, the individual weights of several aggregates of a mixture are printed. The addition and subtraction mechanisms of the printer are used in combination with a suitable programmer to produce a tape showing the net weights of the individual constituents, together with the final total weight of the entire mixture.

Tape printers capable of performing algebraic summations can be equipped with a switch to indicate whether a given total is positive or negative in value. This feature gives rise to interesting applications where the printer, together with suitable electronic instru-

ments, may be applied to determine whether a measured quantity is above or below a specified value.

For example, it may be required to determine if a group of precision resistors are equal to or greater than a specified value. The desired reference value might be set up electrically by a group of tap switches selected by the programmer to insert the low-limit criteria into the printer via an add cycle. The value of the unknown resistance is then measured by a digital ohmmeter and the value is entered into the printer via a subtract cycle. The printer is then totaled and, if the difference is either zero or a negative value, the resistor under measurement is equal to or greater than the low-limit criteria. A signal from a printer switch can then cause the test fixture to eject the resistor into an "OK" bin. A simple extension of this philosophy may be used to determine whether the resistance value falls between two tolerance criteria.

Serial Input Printer

Although most tape printers in use today are of the parallel-input type, there are areas of application in which serial-input printers are indicated, as in transmitting digital data over Teletype facilities. It is possible to obtain serial-input printers capable of either arithmetic or algebraic summation.

Serial-input printers equipped with output commutators (described below) have been employed as mechanical "shift registers." A tape reader can program data into the printer in serial form while the output commutator enables the data to be transferred to other equipment in parallel form. All operations are recorded permanently on the printed tape.

Special Features

Tape printers can be equipped with a wide variety of special dials, punctuation, and zero-suppression formats. In addition to these features there are input keyboards for entering data manually as well as electrically, induction motors for radio-noise-free operation, mechanisms for taking up the printed paper tape as it emerges from the printer, a mechanism to print identification marks, etc.

Scanning Printer

In the printers discussed so far, the entry of data and the control functions are accomplished through the actuation of solenoids. Electronic digital instruments, which present an output by contact closures in decimal form, can be used easily with printers of this type. However, instruments which produce their digital output as "logical levels" in decimal form require a power amplifying device to produce contact closures capable of carrying the currents to the solenoids. Further, most electronic instrument outputs that are at "logical levels" are in coded form; this imposes the further problem of decoding the data, as well as providing amplification.

Until recently, it was necessary to employ amplifying-decoding matrices between instruments such as electronic counters and EPUT meters and the printers which they operated. Such devices are costly and limit the speed at which such data can be recorded.

The scanning printer shown in Fig. 3 can operate directly from the "logical levels" encountered in vacuum-tube or transistor counters, EPUT meters and coded-shaft position transducers, and from decimal contact closures. Negligible power is required from the data sources when operating this printer.

The scanning printer can operate from both decimal and coded data either simultaneously or sequentially. This makes possible easy integration of the scanning printer in checkout or instrumentation systems employing mixed electronic counters and digital voltmeters of the step-switch type. No time is lost in switching between the two types of data as they are presented sequentially, or in programming both types into the printer to be recorded side by side on the same line. As the printer does the decoding during the print cycle, no time is lost in decoding prior to printing.

The standard scanning printer is supplied with a keyboard for manual entry of data onto the printed tape. Many users have indicated a preference for this feature because it enables the operators to insert information from time to time during a test run. The scanning printer, designed to operate from the "logical levels" of electronic digital instruments, represents a significant advance in tape printers.

Electrical Output Commutator

Tape printers can be equipped with decimal contact closures representing the data printed on the tape. The mechanism which provides these contact closures is known as an "output commutator" and makes possible many equipment combinations. It is popular for operating tape and card punching equipment.

Commutators can provide electrical output of sums, differences, algebraic summations, sub-totals, totals, etc., as a result of a series of arithmetic operations.

Some engineers have employed arithmetic tape printers as small, inexpensive computers in systems requiring only low-speed operation. One big advantage is that printed records of all operations are maintained.

Printing Timer

One frequent requirement has been for a tape printer which will compute and print elapsed time together with a progressive identifying number. A machine meeting these requirements incorporates a separate clock motor and digitizing mechanism within a tape printer chassis.

Another printer—the Time Data Printer—prints time of day in addition to other digital data.

Printing Input Keyboard

One of the problems encountered frequently with input keyboards is that operator errors made during entry may pass unnoticed until late in the computation or control cycle. A Printing Input Keyboard eliminates this by printing all entries on a tape. The finished tape provides a visual "quick look" at the data entered, and provides a permanent record which can be attached to the source data and referred to as necessary.

DEFINITION OF ACCURACY OF VOLTAGE-TO-DIGITAL CONVERTERS

The "accuracy" of a voltage-to-digital converter involves the following terms: Absolute Accuracy, Relative Accuracy, Resolution, Precision, Monotonicity, and Linearity.

BERNARD M. GORDON
and
IRWIN M. STONE
Epsco, Inc.

A VOLTAGE-TO-DIGITAL CONVERTER produces a finite set of numbers. For example, a converter with a 10-place binary number output can yield 1,024 different output numbers; a converter with a 3-place decimal number plus sign can yield 2,000 different numbers, and one with a 4-place decimal output with sign can yield 20,000 different numbers, etc. The accuracy of each number must be considered in evaluating the converter accuracy.

It is possible to build voltage-to-digital converters in such a way that not all of the numbers of the complete set are available. In considering the accuracy of a unit it is necessary to state if all of the integral numbers of the complete set are obtainable over the entire range.

For any degree of quality of design, there is always some "dead band" at each quantization level. Regardless of how small this "dead band" might be, there must be some voltage transfer over which either one of two adjacent numbers *might* be obtained at the output. This necessarily presents an ambiguity of quantization decision. By quality design, it is possible to make this "dead band" approach zero, but it cannot be eliminated within the present state of the art.

A better understanding of the factors involved can be achieved by clearly defining "accuracy" in terms of absolute accuracy, relative accuracy, resolution, precision, monotonicity and linearity.

Absolute accuracy is that accuracy which can be obtained with reference to the primary voltage standard maintained at the National Bureau of Standards (given sufficient time to make measurements of the unknown values). In considering the absolute value of any converter, one must consider the *absolute accuracy of the reference* within the converter as well as the circuitry of the converter.

Relative accuracy relates to a percentage of full scale without reference to an external standard. Thus, for example, if a unit were linear and monotonic and the equipment precise (as later defined), its relative accuracy would be limited only by the external components of the converter.

Resolution relates to the least discernible increment of the measurement. Normally, the resolution of any voltage-to-digital converter might be considered to be the least-significant bit. However, if the internal circuits cannot follow minute voltage differences, it is possible to add more digits without obtaining additional resolution. Any specification for the resolution of a converter should be compatible with the number of bits. Otherwise, it is possible to obtain readings implying greater accuracy that actually exists.

Precision relates to the repeatability of measurement. Repeatability can never be better than ± 1 bit.

Monotonicity relates to an increasing output for every increasing value. Lack of monotonicity often shows up symptomatically as "missing codes" from the set. An absolute requirement for monotonicity is that all codes be present and that the quantization level of each be within one-half the least-significant bit of an ideal quantization level.

Linearity refers to whether the output changes linearly with the input. It is possible to plot (1) a function of input voltage against the number which the converter yields, as well as (2) a straight line which might be "continuous numbers" as a function of linear input voltage. If the first curve (quantized output) and the second curve (ideal continuous linear transfer) deviate from each other by more than one least-significant digit and, ideally, more than one-half the least-significant digit, the unit may be said to be nonlinear. If the two units are linear, they will never deviate more than one least-significant bit.

It is possible to have monotonicity without linearity, sufficient resolution, relative accuracy, absolute accuracy, or precision. Monotonicity is a necessary but not sufficient condition. Absolute accuracy implies relative accuracy and also precision and resolution, provided that the definition of absolute accuracy covers all points in the transfer relationship. *Individual linearity, monotonicity, and absolute accuracy, as properly defined, are necessary to determine completely the behavior of a voltage-to-digital converter.*

In practical application, the accuracy of measurement of a varying voltage is related to the accuracy of determining the time in which the measurement is made. Therefore, the speed of conversion also becomes important, even if it is not necessary to make as many measurements every second as is implied by the available conversion rate.

WILLIAM GROSS
Electro Instruments, Inc.

SMALL DIGITAL SYSTEMS

SMALL DIGITAL SYSTEMS generally have advantages of cost and reliability, and disadvantages of lower speed and less data handling capability when compared to their complex high-speed counterparts. These advantages are gained through relatively large-quantity manufacture, which is usually not possible with expensive, high-speed data systems.

If the following parameters, either partially or totally, characterize a specific job, the small digital system should be considered:

1. Physical parameters to be measured can be expressed as resistances, d-c voltages, a-c voltages, d-c/d-c voltage ratios, a-c/d-c voltage ratios, or a-c/a-c voltage ratios.
2. Digital representation to either 4 or 5 digits.
3. Either single- or multi-channel input signal scanning is necessary.
4. Semi-automatic or totally automatic system operation is required (after initial setup). Many functions (such as "go/no-go" comparison of the measured values, certain data computation to minimize final data reduction and programmed readout at periodic intervals) are included in this operation characteristic. These factors are of major importance in economic justification of the cost of a digital data system.
5. Digital data recording at rates up to five per second is required on any one or more of the following recording devices: parallel-entry strip printers (such as the Hewlett-Packard, Clary, Victor, Monroe or Friden); serial-entry page printers (which include IBM and Friden electric typewriters); Friden and Teletype paper tape punches; and IBM summary and key card punches.

Typical Applications

Operation characteristics are presented for low-, medium- and upper-cost systems within the range of $5,000 to $35,000.

Fig. 1 illustrates a basic system that monitors a single channel where the analog data is a variable d-c voltage. The analog is digitized by a 5-digit digital voltmeter. Digital data is recorded on a Hewlett-Packard parallel-entry strip printer. System programming and control are set at the printer (which is typical for all systems discussed).

Fig. 2 illustrates a system similar to that shown in Fig. 1 with the following additions and changes: An input signal scanner with a pre-amplifier has been added to scan 200 low-level d-c voltage transducers. Digital data is recorded on an IBM electric typewriter.

The system shown in Fig. 3 generally is used where several types of analog signals must be measured. A typical application is incoming inspection, quality control, or environmental performance evaluation of transistors and diodes. This system includes a 100-channel input signal scanner; it can digitize resistance, d-c voltage, a-c voltage and d-c/d-c voltage ratio analogs. Digital equivalents of these analogs are recorded on an IBM typewriter for a "quick look" and on punched paper tape for additional data reduction by a digital computer.

An important characteristic of this class of digital systems is that performance capability can be expanded by adding additional modules.

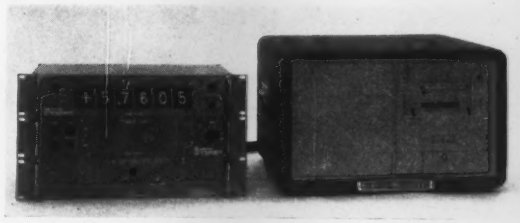


FIG. 1. SINGLE-CHANNEL, d-c voltage monitor, 5-digit readout, and strip printer.

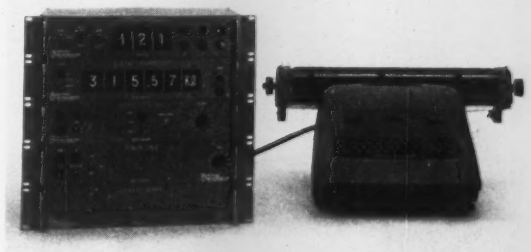


FIG. 2. 200-CHANNEL SCANNER, channel indicator, digital readout and typewriter printer.

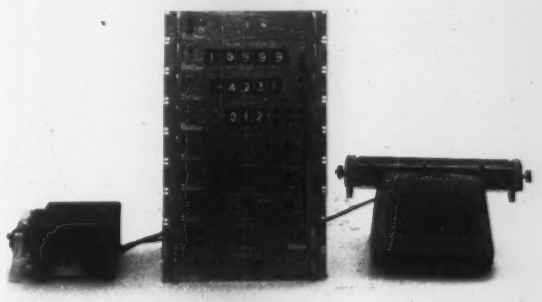


FIG. 3. 100-CHANNEL SCANNER and digitizer for d-c voltage, a-c voltage and d-c/d-c voltage ratio. Output is digital readout, typewriter printer and punched-tape recorder.

Magnetic Tape Equipment

This survey of magnetic tape equipment includes recorder/reproducers of many types and sizes, degaussers and erasers, magnetic tapes, and tape testers.

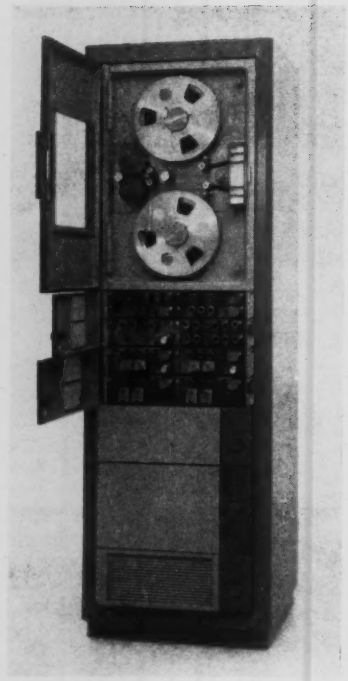


FIG. 1. AMPEX line includes FR-100A (left) and mobile series 800B (below).

AMPEX

The Ampex line includes analog, FM, PDM and Digital units.

The FR-100A (Fig. 1) modular magnetic tape recorder provides up to 14 tracks with interchangeable amplifiers permitting direct, FM, PDM or NRZ digital recording on any track. Six tape speeds range from 1⅞ to 60″/sec. At tape speed of 30″/sec flutter is less than 0.1% peak-to-peak from 1.5 to 500 cps cumulatively; gap scatter is less than 100 microinches; servo speed control provides time-base accuracy to two parts in 10^5.

The Series 800B is a mobile or airborne unit.

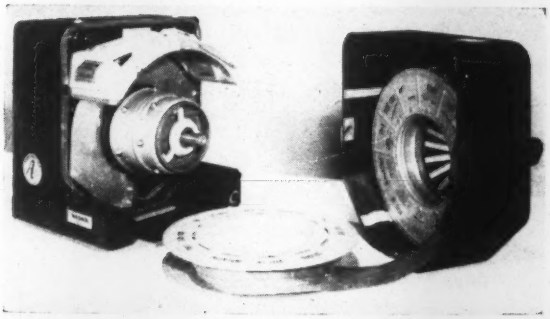
The digital tape systems include Models 200A, 300, and 400. The 300, with 150″/sec tape speed can transfer six-bit alphanumeric characters at 30,000 characters per second, using ½″ tape and 200 bits per inch packing density, and up to 90,000 characters per second using 1″ tape and 300 bits per inch. It has start and stop times of 1.5 ms; flutter of 1% for 0-30 cps pass band; time displacement error is ±4.8 microseconds from center clock for 1″ tape.

Ampex also offers a tape-loop recorder and the FR-1100, a low-cost general-purpose instrumentation recorder.

New Ampex product is Ampex Computer Tape, combining high output, high bit-packing capacity, and long life (is said to "last ten times longer in use than conventional precision tapes"). Designated C1 (on 1.0-mil Mylar base) or C2 (on 1.5-mil Mylar), tape is furnished in standard widths of ½″, 1″ and in lengths of either 3600′ or 2500′ on 10½″ reels.

APPLIED MAGNETICS

"Amco" makes a 15-head stack and specializes in heads made to customer specifications. Product line includes eleven different heads, from one to 15 tracks.



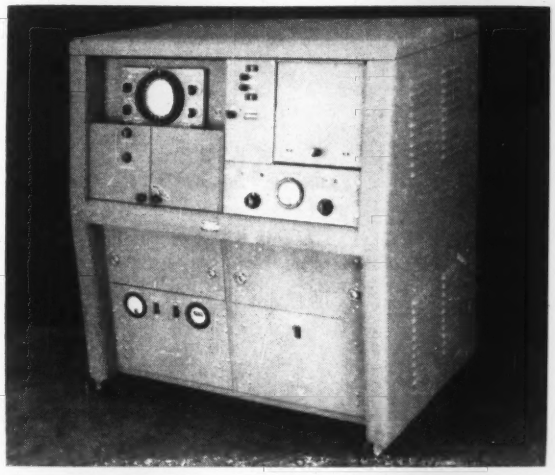


FIG. 2. NADAR airborne housing and tape magazine, and ground playback and test console.

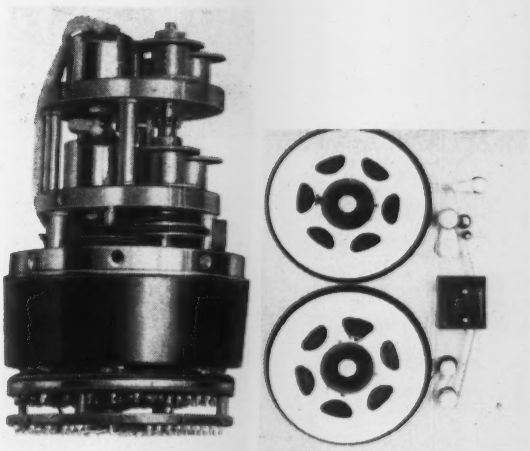


FIG. 3. BJ NORTHAM airborne rocket test recorder (left) withstands ground impact. Model MR-100 (right) holds 3600' for 12-hr running time.

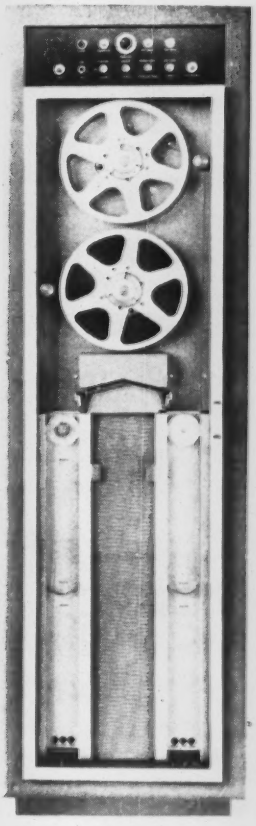


FIG. 4. ELECTRODATA Model 53368 digital tape unit with 4-million character capacity.

AUTONETICS

Autonetics Division of North American offers Nadar IIA (Fig. 2), an airborne recorder and ground-based reproducer system designed especially for pilot evaluation and training in fire control. Signals recorded represent artificial horizon, including pitch, attitude, target azimuth, reference circle, time circle, steering dot, target range, and opening or closing range rate on four tracks of 1" tape. Recorder frequency response is ±3 db from 30 to 1500 cps; tape speed is 6 to 9"/sec; crosstalk is 30 db down between channels. After mission, tape magazine is installed in reproducer for playback of pilot's display on dual-beam CRO.

BJ ELECTRONICS

BJ Northam (Fig. 3) Model MR-2B miniature magnetic tape recorder for airborne rocket test (direct recording) weights 4½ lb with armor. Reel capacity is 40' of ½" tape; seven tracks (6 for data, 1 for timing) and seven tape speeds are available from ¼ to 15"/sec. Frequency response is 0 to 250 cps for AM-erase technique. Accuracy is ±5% full scale. Ruggedized to withstand ground impact.

Model MR-11B is a double-deck version providing 16 (14 data, 2 timing) tracks on dual ½" tapes.

Airborne Model MR-100 carrier erase or digital recorder for other than high-g environments, is a miniature that provides 7 tracks on ½" tape. Tape speed is 1"/sec ±2%; flutter is 3% peak; reel holds 3600' for 12-hr running time. Dimensions are only 19" x 24.5" x 10"; weight is 25 lbs with full reel.

BURROUGHS

ElectroData Division of Burroughs Corporation offers several transports, including the Model 53368 digital tape transport (Fig. 4) featuring data manipulation at various speeds. It provides 10 tape speeds

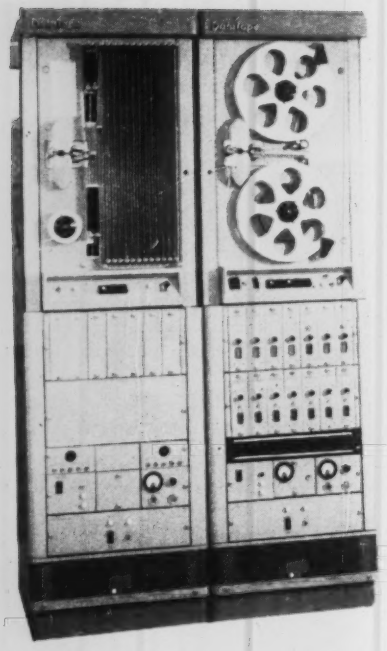


FIG. 5. CEC line includes Type 5-781 continuous-loop unit (top left), Type 5-752 reel recorder (right), MicroSADIC data processing system (bottom).

from 1.5 to 90″/second; stop time is less than 8 ms at 45″/sec; start time to 90″/sec speed is less than 7 ms; dynamic skew is less than 2 minutes of arc at all speeds. Reel capacity is 2600′.

All transports incorporate vacuum controlled reel servo systems for gentle tape handling, end-of-tape sensing, fast start and stop, remote and local control, easy threading and dust free operation. A file protection device and air-conditioning manifolds are available.

FIG. 6. CINEMA Engineering tape degausser (left) and magnetic erasing pencil (bottom).

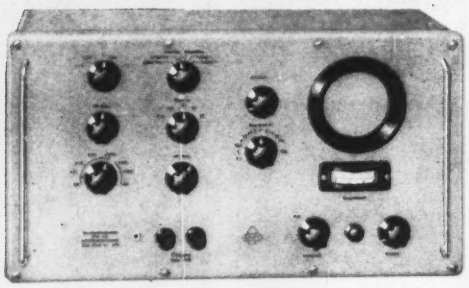


FIG. 7. ELEKTROMESSTECHNIK wow and flutter test set imported by Electronic Applications.

CONSOLIDATED ELECTRODYNAMICS

DataTape Division of Consolidated Electrodynamics Corporation offers a line of tape recorders.

The Type 5-752 Recorder/Reproducer (Fig. 5) simultaneously records and reproduces from 1 to 14 tracks on standard tape sizes from ¼″ to 1″. Maximum reel size is 14″. Cumulative peak-to-peak flutter is 0.05% for any single frequency. Tape speeds are from 1⅞″ through 60″ per second; data can be recorded and reproduced in analog, FM, and PDM modes.

CEC Type 5-781 14-track Continuous Tape Loop Recorder/Reproducer drives closed loops of from 2′ to 75′ at speeds from 1-⅞″ through 60″ per second. It is used for the study of transient responses, time delays, etc.

A compact DataTape Mobile Recorder features high-altitude, high-temperature operation, six tape speeds and 7- and 14-track operation.

The MicroSADIC data processing system, which uses a Type 5-680 Digital Recorder/Reproducer, can convert analog signals to digital signals and record the digitals at rates to 10,000 samples per second.

CINEMA ENGINEERING

Type 9205 *tape and film degausser* (Fig. 6) of Cinema Engineering Div., uses two powerful fields to degauss up to 5400′ reels of ¼″ tape.

Type 8905 magnetic erasing pencil, with active area of only 0.281″ dia. can erase a word or a syllable or any limited small area of tape.

Both operate from 110-volt sources.

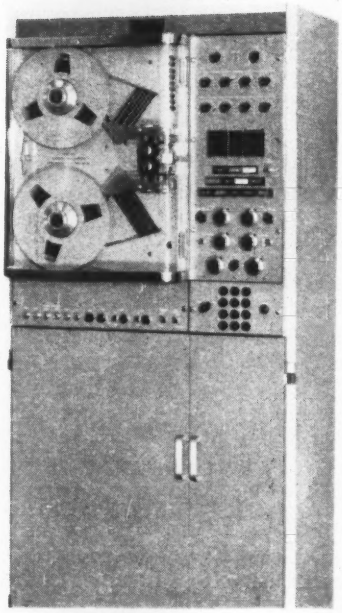


FIG. 8. ELECTRONIC ASSOCIATES' Dataplotter directs plotting of x-y graphs.

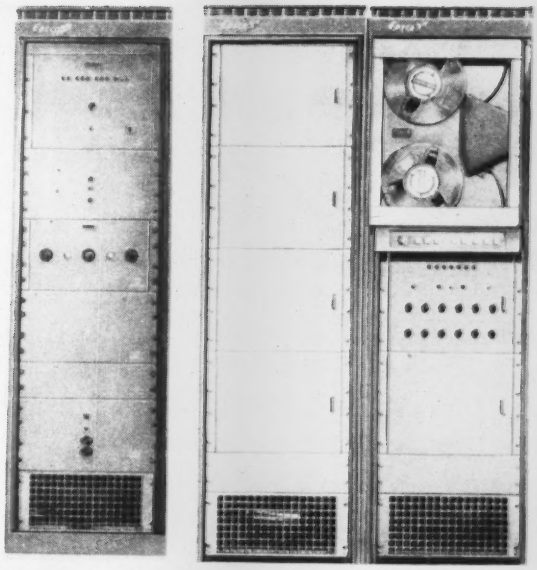


FIG. 9. EPSCO digital recorder stores 270 13-bit words plus time code data. Digital conversion system is shown at left, recorder at right.

ELECTRONIC APPLICATIONS, INC.

Electronic Applications, Inc., is distributor for a line of precision wow and flutter test sets (made by Elektromesstechnik Wilhelm Franz KG, Western Germany) and also portable, battery-operated tape recorders.

The wow and flutter test set EMT418 (Fig. 7) measures wow and flutter, either AM or FM. Measuring frequency is 3 kc.

Wow meter Model J60 b uses a test frequency of 5 kc and measures to 3% frequency modulation. Output connections are provided for (1) amplitude level recorder, (2) light-beam galvanometer, and (3) oscilloscope.

NAGRA III B portable tape recorder/reproducer is battery powered, with tape speeds of 15, $7\frac{1}{2}$, and $3\frac{3}{4}$ ips, uses 5" or 7" reels; flutter is within NAB studio standards.

Other imported items include tape editing equipment and playback-time regulator for compression or expansion of tape without pitch alteration.

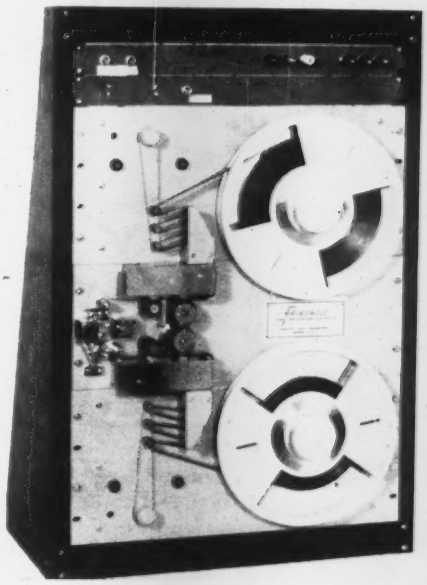


FIG. 10. FAIRCHILD F411 digital magnetic tape handler has bad-spot detector, end-of-tape sensor.

ELECTRONIC ASSOCIATES

Electronic Associates' Models 4.016 and 4.017 Dataplotters (Fig. 8) operate with EAI Variplotters to convert digital tape data into plots on x-y graphic recorders. Equipment has resolution of 0.005% of full scale. Three types of plots can be made—(1) point plots, (2) symbol plots, and (3) line plots. Tape speed is 75"/sec. Data range is from +9999 to −9999.

EPSCO

Epsco's Model RS-104 digital recorder stores 270 13-bit digital data words plus 20 characters of fixed data and 36 characters of time code data. Block lengths can be varied from 1 to 835 characters. Word rates can be accepted up to 36000 data words per sec. Model is part of integrated system for data reduction via FM, PAM (pulse-amplitude modulation), and PDM. Rack shown at left in Fig. 9 is PAM-to-Digital Conversion System; double rack at right is Digital Recorder.

FAIRCHILD

Fairchild F411 digital magnetic tape handler (Fig. 10) is compatible with IBM systems. It will take $\frac{3}{4}$" tape and provide for up to 12 tracks. Its rugged con-

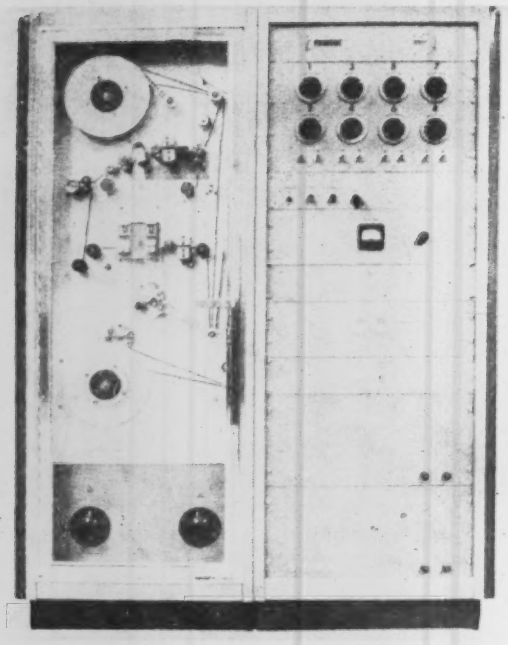


FIG. 11. GENERAL KINETICS' tape tester detects flaws and punches holes spanning any defect.

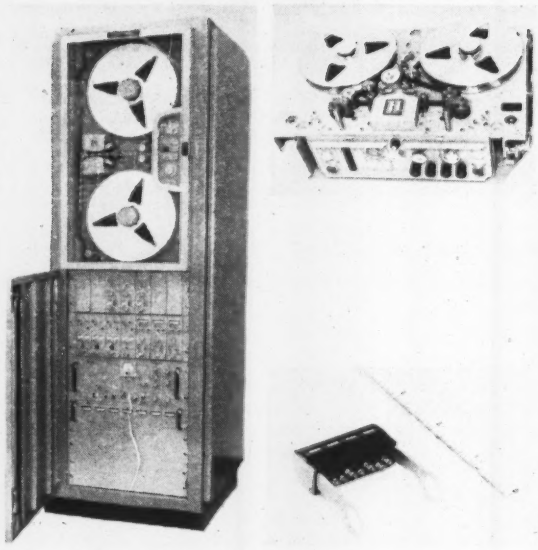


FIG. 12. HONEYWELL Series 3170 system (left) handles 2" tape on 14" reels. Type 3111 transport (upper right) is for airborne use. Custom head (lower right) reads checks and accounting cards.

struction insures continuous service. The most important features are a bad-spot detector, end of tape sensor, and a 2500' capacity.

GENERAL KINETICS

The Model U-1 Computer Tape Tester (Fig. 11) was designed to test the metallic magnetic tape used by the UNIVAC system. Similar machines can be supplied for testing plastic computer and instrumentation tapes. It automatically locates and punch-marks portions of the tape which contain flaws.

The tester records pulses on the UNIVAC tape in a continuous stream at the spacing of the UNIVAC computer. Eight pickup heads check the recorded pulses during playback for amplitude and rise time. If any pulse falls below a preset adjustable threshold a defect is indicated and two holes are punched spanning the defect. The recording and playback operations occur with the tape moving at a constant velocity. The punching causes the tape to stop momentarily in the region of the punch but a coupled slack loop system prevents this tape stoppage from affecting the tape.

The system includes a provision for locking out the checking operation in regions that have already been indicated as defective by holes punched, and a system for counting the total number of punched holes on the tape and the total tape footage.

Tested speed is 25" per second.

HONEYWELL

Davies Laboratories Division of Honeywell reports an extensive line of magnetic tape instrumentation, for both analog and digital data acquisition, and for both fixed and mobile (airborne) applications.

Top of the line includes the Series 3170 systems (Fig. 12). These are precision, fixed multi-track data recorder/reproducers for laboratories, telemetry and other demanding uses. Standard modules are assembled into custom systems meeting users present and future needs. Transport has six switch-selected speeds from 1½ or 1⅞ to 60 ips. Are said to be "only standard transports on the market handling 14" reels and tapes as wide as 2".

Honeywell will soon announce an airborne recorder matching the precision and performance of the 3170 systems. The standard line of airborne systems includes 4 units ranging from 8 to 55 pounds, with tape as wide as 1¾" runnning 24 minutes at 30 ips.

Honeywell also offers facilities capable of both prototype and large scale production of custom magnetic recording *heads* (Fig. 12).

Other Honeywell tape products are loop transports, multichannel voice monitors for airport control towers, automatic wave analyzers, and the 10,000 sample per-second Digital Data Recorder Transcriber.

IBM

IBM line includes the 705 III that reads and writes 60,000 characters/sec; tape density is 534 characters/inch. 14 million characters can be read or written in less than 4½ minutes. Model 729 reads or writes 15,000 characters/sec; tape density is 1200 digits/inch. Two-gap read-write head checks data as it is written. 727 unit reads or writes 15,000 characters/sec; density is 200 characters/inch.

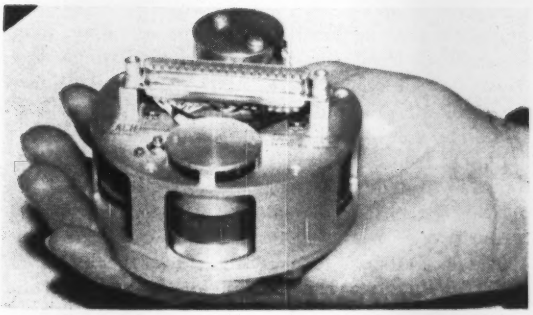


FIG. 13. LEACH airborne recorder can operate during 2000-g impact.

LEACH

Leach Corp. 24-oz tape recorder (Fig. 13) for airborne use is said to be world's smallest. Seven tape speeds are available from 0.25 to 15″/sec; tape widths are ½″ and 1″; flutter is less than 1%. Can operate during 2000-g impact.

MINCOM

Mincom (Div. of Minesota Mining & Manufacturing Co.) C-100 (Fig. 14) instrumentation recorder/reproducer provides six speeds, from 3¾ to 60″/sec. Tape width can be ¼″, ½″ or 1″, with 1 to 14 tracks. Frequency response ±3 db from 100 cps to 100 kc at 60″/sec. Flutter is 0.1% peak, from 0.1 cps to 4 kc at 60″/sec.

CV-100 records and reproduces seven 1-Mc video channels on ½″ tape. Frequency response from 400 cps to 1 Mc is ±3 db at tape speed of 120″/sec. Running time using 14″ reels and 1-mil tape is 12 minutes. Flutter is 0.1% peak, from 0.1 cps to 4 kc. Signals-to-noise is 30 db, peak signal to rms noise; timing accuracy is 0.005%.

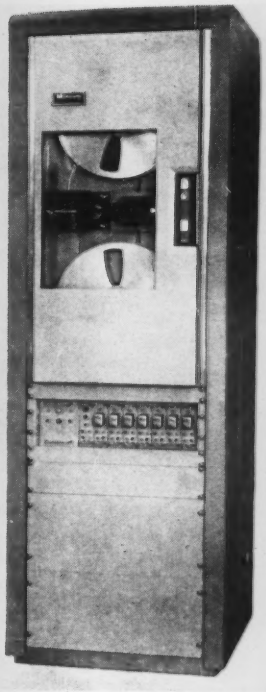


FIG. 14. MINCOM C-100 recorder/reproducer has 0.1% peak flutter from 0.1 cps to 4 kc.

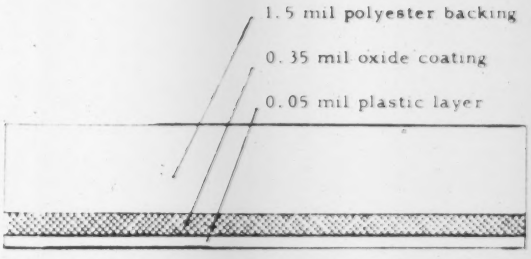


FIG. 15. SANDWICH TAPE by Minnesota Mining & Manufacturing has 0.05-mil layer of plastic over oxide coating to eliminate oxide rub-off.

MINNESOTA MINING & MANUFACTURING

New #186, #188 and #189 instrumentation tapes of Minnesota Mining & Manufacturing Co. sandwich the magnetic coating under a thin (50 microinch) plastic film (Fig. 15). This sandwich tape eliminates oxide rub-off and is said to have not more than a single dropout in a 2500′ roll of ½″ tape. (Dropout here means reduction to less than 50% normal signal amplitude on any of seven tracks carrying 220 NRZ pulses per inch.) Different types of instrumentation tape feature output, strength, resolution, etc.

PACKARD-BELL

Aerotape, by Packard-Bell Electronics Corp. (Fig. 16) is a direct-recording modular airborne recorder/reproducer that weighs 10 lb. Tape magazine has only one reel and tape is transferred between inner and outer diameters.

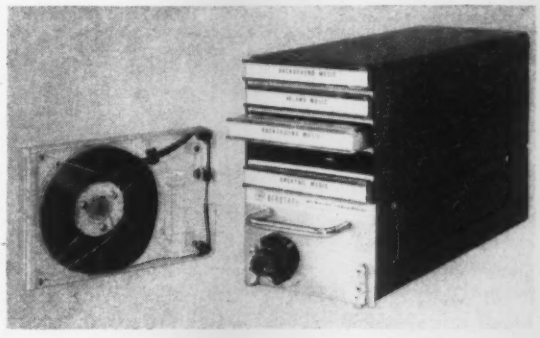


FIG. 16. AEROTAPE airborne recorder features single-reel transport.

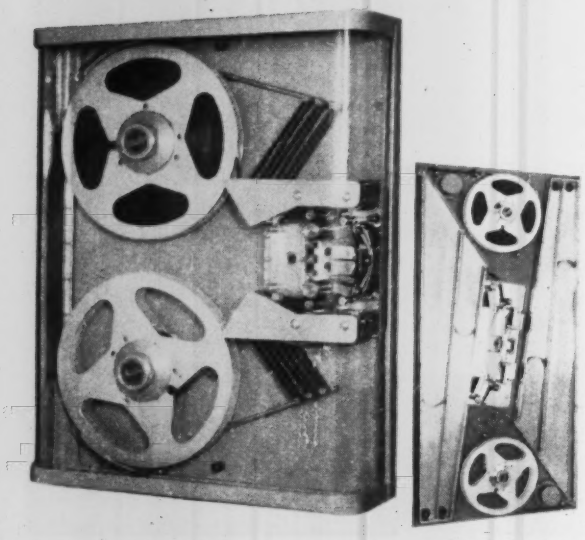


FIG. 17. POTTER Model 906 transport (left) also handles perforated paper tape. Model 908 (right) can run tape at 150"/sec.

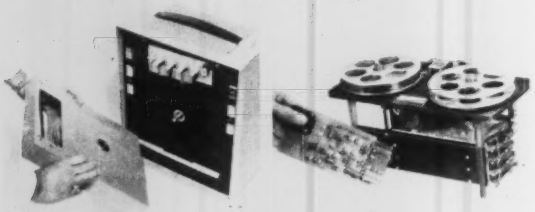


FIG. 18. PRECISION INSTRUMENT "Simplex" (left) is transistorized and features clip-on tape magazine. Mobile unit (right) provides to 60 hrs recording of 7 channels.

POTTER INSTRUMENT

The Potter line includes the Model 906 transistorized digital magnetic tape handler designed for standard rack mounting (Fig. 17). Replaceable capstan panel permits use as a perforated tape reader. Start time is less than 3 milliseconds, stop time less than 1.5 milliseconds; tape widths to 1¼", up to 47 channels, speeds to 150"/sec, search or rewind 300"/sec. Can stop on second character at speeds up to 1000 characters/sec.

Model 3280 transistorized digital transport is designed for data transfer rates of 1500 characters per second or less.

Model 910 is a medium speed digital magnetic tape transport for character transfer rates up to 18.8 kc on ½" tape, or 30 kc on 1" tape.

Model 908 (Fig. 17) high-speed transistorized digital transport features character transfer rates to 45 kc on ½" tape, and 90 kc on 1" tape. Start time is less than 3 ms; stop time less than 1.5 ms. Stop distance is 0.125" ±0.035". Vacuum tank slack loop system accommodates 160" of tape for each reel. Tape speed up to 150"/sec with flutter ±1%; time displacement jitter is ±1 microsecond at 150"/sec from center clock to outside track on ½" tape. Features include remote control and in-line loading.

Model 921 family of transistorized record-playback amplifiers provide function selection switching, plug-in amplifier cards for different head windings, tape speeds, output signals, etc.; "AND" gates are included for clock drive inputs and control logic. Standard signal is 0 volt logical one, and —10 logical zero.

Potter record-playback heads provide up to 25 tracks in a single stack or as a dual read-write stack—up to 49 tracks on a dual-gap interlaced stack. Gap scatter tolerance is ±0.00005". Track widths are available from 0.020" to 0.125"; track spacing from 0.050". Windings can be single, dual and center tapped.

PRECISION INSTRUMENT

PS-200 "Simplex" transistorized recorder/reproducer (Fig. 18) is made by Precision Instrument Co. Self-threading, self-aligning tape magazine clips on front and eliminates threading. Holds standard 10½" reels and provides tape speeds from 3¾ to 30"/sec with flutter (measured from zero to 300 cps) less than 0.1% rms. Standard tape width is ½", up to 7 tracks. Gap scatter is 200 microinches; inter-stack tolerance 0.001"; skew within 02 mils per inch. 7 channel model weighs less than 50 lbs; said to be only "magazine-loading portable instrumentation recorder."

TT-100 5-lb lab and airborne unit features tape speeds with 0.1% tape speed accuracy. Power is 6-v dc.

REEVES SOUNDCRAFT

Type A Instrumentation Tapes #400 and #420 are coated with Soundcraft's RCCH oxide formulation. This exclusive coating insures that the tapes will have long dropout-free service life. Soundcraft tapes are tested so that there is a 50% margin of safety against dropouts when being used on field equipment.

In addition to the two types of Type A digital tapes, Reeves Soundcraft offers special instrumentation tapes for numerical control and telemetering; also a video instrumentation tape.

REMINGTON RAND

The Remington-Rand Uniservo (Fig. 19) is the means by which the Univac System reads from or writes on magnetic tape. The Univac system can be provided with up to 16 Uniservos.

Unityper II records data typed on its typewriter keyboard onto magnetic tape. Thus a typist prepares magnetic tape used to command the Univac computer. Unityper requires 120 characters to a line and 720 characters to a block so that tape data meets computer requirements.

The Verifier is a unit that checks the recording of tapes prepared by the Unityper (against a second typing of the original source document). It also can be used as a Unityper.

An automatic tape unit designed for use with the Univac file-computer makes comparisons, logical decisions, and is self-controlling. Central computer can perform other functions while the tape unit searches tape for the data the computer wants. Up to ten units can work simultaneoulsy.

WESTERN ELECTRO-ACOUSTIC

A portable direct recorder/reproducer (Fig. 20) is offered by Western Electro-Acoustic Laboratory, Inc., especially for noise and vibration signals. It is a dual channel unit, has over-all frequency response ±1 db from 30 cps to 30 kc at 15″/sec. Flutter is less than 0.1% rms; dynamic range to 1% signal distortion is 40 db in lower and highest octave band, and better than 60 db in the middle bands. There is no pre-equalization; playback equalization is by a constant-phase network.

LATE EQUIPMENTS

American Concertone

Model R168 industrial magnetic-tape transport (Fig. 21) is currently being supplied to manufacturers of machine-tool programming equipment. The R168 transport uses three motors with a hysteresis-synchronous direct-drive capstan motor and heavy duty torque-type reel motors. It is push-button operated, accommodates reel sizes up to 10½″ and handles either ¼″ or ½″ tape. Speed ranges are from 1⅞ to 30″/sec.

ITT

ITT Laboratories has developed a 22-track tape transport that reads or writes at 30,000 characters per second. Bidirectional to speed access time, tape speeds are available to 500 feet per minute (100″/sec). Full speed is attained from stop in 1 ms. "Storage-bin" feature eliminates need for reels.

Magnasync

A line of turntable degaussers is offered by Magnasync Manufacturing Co. Entire reel is placed on turntable, and reel is turned so that it passes over degaussing section. Model A-397 features a 20-second timed cycle for fast and complete bulk erasure; Model M-937 is manual unit; Model G-936 is conventional degausser.

Telectro Industries

Telectro Industries Corporation has introduced a 14-channel 6-speed data recorder-reproducer, with speed range from 1⅞ to 120 ips; 28 tracks are available on 1″ tape. Amplifiers are available for AM, FM and PDM.

Thompson-Ramo-Wooldridge

A magnetic tape unit (shown in Fig. 22) has been designed for use with the RW-300 digital computer, creating a new on-line data reduction system for test facilities. The system eliminates need for separate data acquisition, conversation, translation and processing equipments.

Up to 8 transports (Modified Ampex FR400 units) can be coupled to the computer through a magnetic-core buffer. Each transport has a storage capacity of 1.3 million computer words of 18 bits each. Data can be collected and recorded at a rate of 2,560 words per second. Data can be smoothed, scaled, linearized and corrected for errors with calibration constants by the computer.

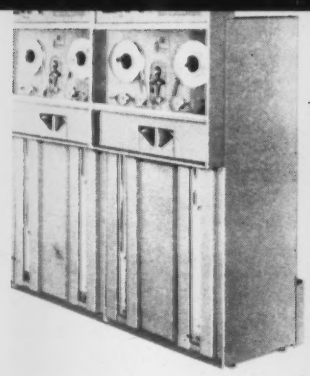


FIG. 19. REMINGTON-RAND Univervos (top) tie in with Univac computer operation. Unityper II (left) permits preparing digital computer commands by typing. Verifier (right) checks tape.

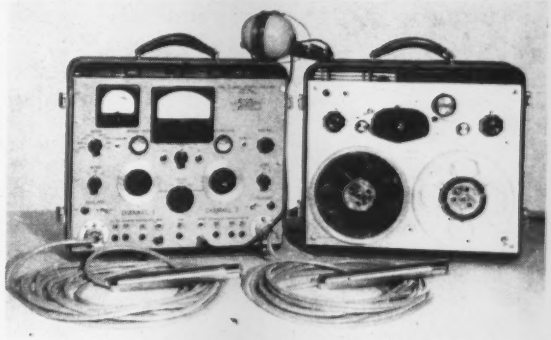


FIG. 20. WESTERN ELECTRO-ACOUSTIC'S portable dual-channel unit is designed for noise and vibration studies.

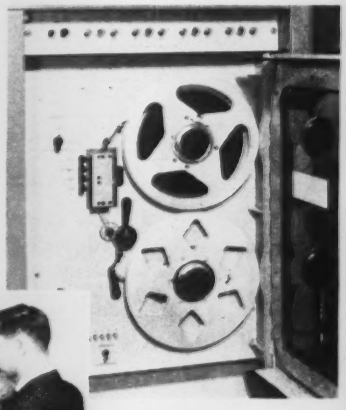


FIG. 21. AMERICAN Concertone industrial tape transport.

FIG. 22. RW-300 magnetic tape unit.

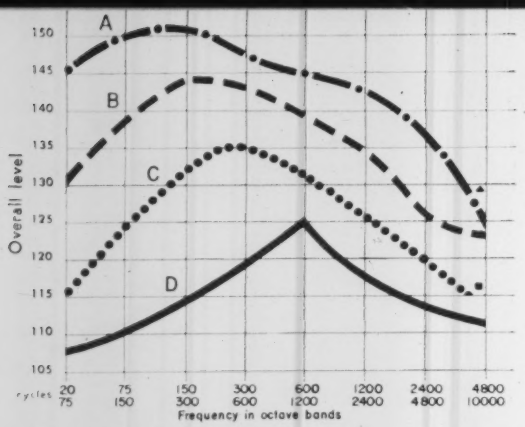


FIG. 1. SOUND LEVELS (db) vs frequency (octave bands) at (A) wing near jet, (B) rear of fuselage, (C) center of fuselage, (D) forward in fuselage.

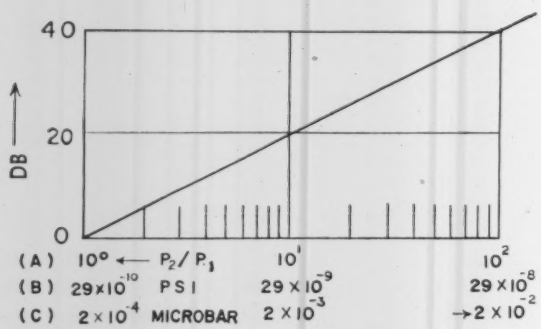


FIG. 2. UNITS in acoustic work. Sound pressure level in db (referenced to 2 x 10^{-4} microbars) is plotted against pressure ratio (P_2/P_1), psig, and microbars. Curve can be extrapolated linearly in either direction.

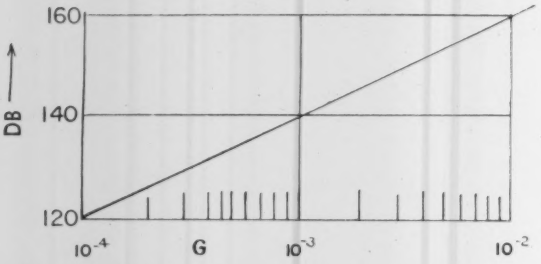


FIG. 3. OUTPUT (g) of accelerometer vs sound pressure level in db, when accelerometer has acoustic sensitivity of 10^{-5} g/100 db. Curve can be extrapolated linearly in either direction.

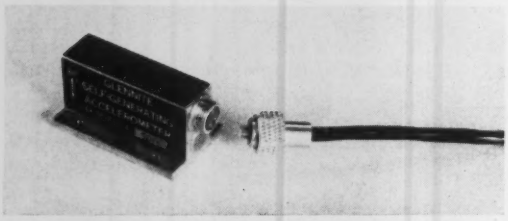


FIG. 4. ACCELEROMETER with acoustic sensitivity of 10^{-5} g/100 db. (Courtesy Gulton Industries, Inc.)

Acoustic Sensitivity

HIGH ACOUSTIC NOISE LEVELS are known to be damaging to some classes of electronic equipment and can cause severe tube microphonics with resultant degradation of circuit performance. Relay chatter and other undesirable intermittents have been reported.[1] Not so well known is the effect of acoustic noise on instrumentation accelerometers, particularly in producing a fictitious vibratory acceleration signal.

The sensitivity of an accelerometer to acoustic noise depends on the actual sound pressure levels at the location of the accelerometer. Empirical studies[2] have indicated that the compartment in which the accelerometer is mounted can contribute an attenuation of considerable magnitude. Fig. 1 shows sound levels vs frequency for a jet-engine vehicle with instrumentation bay.

The design of the accelerometer also can affect its sensitivity to noise and vibration. Accelerometers employing case-clamped barium-titanate elements, for example, are more susceptible to noise than enclosed cantilever or center-disc supported elements. Of course other parameters are involved, but the ultimate choice of the measurement instrument should include environmental as well as system compatibility. Further, recordings of acoustical noise and vibration should be made independent of each other.

Although no specific acoustic noise levels can be presented relative to an exact missile configuration, typical values[4] are shown in Table 1.

Units

Sound pressure can be expressed in psig or in microbars (dynes/cm²). It also can be expressed as a *ratio* in db. When using db, the zero-db point is the *reference level*, or the denominator in the familiar formula for db:

$$P_2 \text{ (db)} = 20 \log P_2/P_1$$

where P_1 is the 0-db or reference level; P_2 and P_1 are *pressure* levels. The accepted pressure reference level in the acoustic field is 2 x 10^{-4} dynes/cm². Hence 0-db sound pressure level means 2 x 10^{-4} dynes/cm².

Note: 1 dyne/cm² also equals 1 microbar.

Sound *intensity* also can be expressed in watts/cm², which is a power term. The familiar db formula in terms of power is

$$I_2 \text{ (in db)} = 10 \log I_2/I_1$$

# of Accelerometers

ALVIN B. KAUFMAN
Litton Industries

where I_1 is the reference intensity. The accepted value for I_1 is 10^{-16} watts/cm^2. Hence 0 db in terms of watts/cm^2 is 10^{-16} watts/cm^2.

Sound pressure can be expressed in psi from the simple handbook relation between psi and dynes/cm^2:

76 cm Hg = 14.697 psi = 1,013,200 dynes/cm^2

Hence to convert microbars to psi, multiply by (14.697/1,013,200) or 1.45 x 10^{-5} psi/microbar.

Table 1 and Fig. 2 show these relations.

Expressing sound pressure in psi is more practical for the instrument engineer because it is easier to visualize than the minute microbar or dyne units.

Acoustic Sensitivity

The acoustic sensitivity of an accelerometer is its g output (undesired) caused by acoustic noise (usually expressed in db). Where the acoustic sensitivity of the accelerometer is known, its output for a given sound level can be determined from Table 1 or Fig. 2.

For example, in an ICBM application, the vendor specifications on the Glennite A500 piezoelectric accelerometer used (Fig. 3) said that the acoustic sensitivity corresponded to less than 10^{-5} g/100 db (referenced to $2x10^{-4}$ microbars, 0-db level). This acoustic sensitivity of 10^{-5} g/100 db appears to be an insignificant quantity, and may well be *depending on the sound level encountered and the vibratory force to be recorded*. However, note in Fig. 3 that a sound level of 200 db (29 psi) produces an error of 1 g at an acoustic sensitivity of 10^{-5} g/100 db. Note also that 220 db (290 psi) creates an error of 10 g. It is highly probable that these sound levels, where encountered, will be accompanied by g forces of very high magnitude, thus producing a small percentage of measurement error. In the application noted, vibratory forces of 20-30 g were expected, accompanied by an acoustic noise level below 180 db (2.9 psi) which, for the referenced accelerometer, produces an acoustic g noise level of 0.5% or less.

The possibility exists that the acoustic sensitivity of the accelerometer used can increase exponentially or irregularly with the application of linear pressure values. Such a condition is not probable, but it would invalidate the information in Fig. 3.

Tube microphonics in support equipment or in the accelerometer (the A500 accelerometer contains an integral electronic tube) can cause irregular noise at acoustic levels of 120-140 db.[1]

Where the acoustic sensitivity of the accelerometer is unknown, or where it is desired to verify a manufacturers specifications, or to determine the acoustic response throughout a given db range, empirical tests must be performed. Acoustic noise producing and measurement equipment for tests to about 150 db are available commercially.[4,5] Acoustic noise equipment for levels above 150 db do not appear readily available. Also there appears to be diverging opinions over the use of white noise *vs* scanned octave frequencies. The author feels that both methods of measuring acoustic sensitivity should be employed where feasible.

It is not recommended that accelerometer noise tests be conducted in or near the path of turbulance generated by rocket boosters or jet engines. The high intensity blasts of jets and especially rocket boosters will be reflected by induced ground vibrations on supporting structures and the accelerometer under test. Thus any accelerometer output would reflect true vibratory motions combined with acoustic signals. Also, the noise spectrum is unknown. Commercial acoustic equipment also should be examined to verify that the accelerometer mounting is not being vibrated, thus producing a false indication of acoustic noise.[7]

TABLE 1—ACOUSTIC NOISE LEVELS AND RELATIONSHIPS

Sound Pressure Level, db	Pressure Ratio P_2/P_1	Sound Pressure, dynes/cm^2 (microbars)	Sound Intensity, watts/cm^2	Sound Pressure, psi	Sound Pressure Level Corresponding to:
00	1	$2x10^{-4}$	10^{-16}	$29x10^{-10}$	Threshold of hearing
20	10	$2.0x10^{-3}$	10^{-14}	$29x10^{-9}$	
30		$6.3x10^{-3}$	10^{-13}		Average noise in open country
40	100	$2.0x10^{-2}$	10^{-12}		
70		$6.3x10^{-1}$	10^{-9}		Conversational speech
100	10^3	$2.0x10$	10^{-6}	$29x10^{-5}$	Transducer calibration
130		$6.3x10^2$	10^{-3}		Threshold of pain
160	10^8	$2.0x10^4$	1.0	0.29	Military Jet Aircraft
194		$1.0x10^6$	$2.5x10^3$	14.7	Atmospheric Pressure
200	10^{10}	$2.0x10^6$	10^4	29.0	Ballistic/Ramjet Missile
220	10^{11}	$2.0x10^7$	10^6	290	

References

1. R. Kaminski, "Airborne Components in an Intense Acoustic Environment," *Environmental Quarterly*, First Quarter, 1958, Institute Environmental Engineers.
2. F. Mintz, M. Levine, "Testing Airborne Electronic Components," *Electronics*, March, 1955, pages 181-183.
3. *Handbook of Chemistry & Physics*, 34 Edition, page 2660, Chemical Rubber Publishing Co.
4. RCA High-Intensity Noise Systems, Bulletin: Form 3R5182.
5. John K. Hilliard, "Microphones Measure High-Intensity Sound," *Electronics*, Nov. 1953.
6. W. B. Conover, "Combining Sound Levels," *Electronics Buyers Guide*, June, 1954.
7. R. H. Jacobson, "The Scream of a Jet-In a Six-Inch Test Cell," *Electronic Industries & Tele-Tech*, Feb. 1957.

SCANNER OR MONITOR?

NORBERT E. WEBER
The Foxboro Company

The difference appears small—but it is significant, particularly in cost.

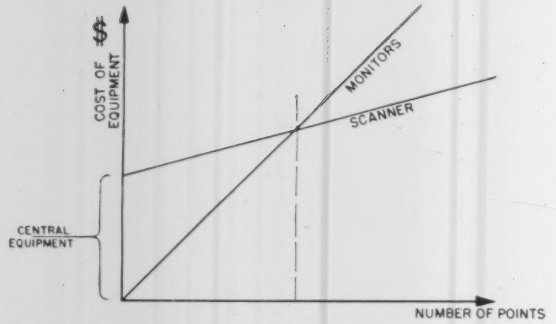


FIG. 1. RELATIVE costs of a scanner and monitor system.

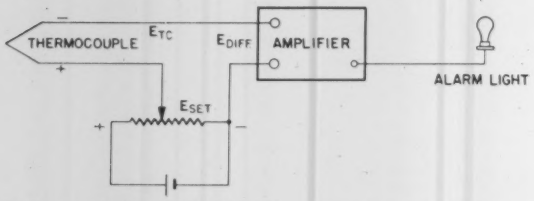


FIG. 2. MONITOR SYSTEM for one thermocouple. Complete system must be duplicated for each monitor channel.

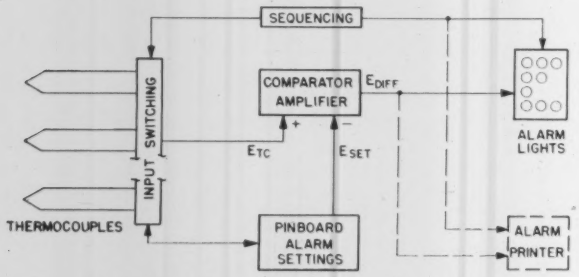


FIG. 3. IN A SCANNER system, the amplifier and periphery equipment is shared and, hence, only one is needed.

A SCANNER can be defined as a sequential reviewer of data in one central location; a *monitor* as a full-time reviewer of such data. The difference appears small, but it is significant.

Cost considerations distinguish scanners from monitoring systems. For a scanner to be economical, it is obvious that the final per point cost must be less than that of the equivalent monitor. This rules out the scanner for alarms of simple pressure signals; a $15 pressure switch cannot be improved upon cost-wise by any scanning device now available. However, for thermocouples, the facts are different because the precise measurement of one temperature by thermocouple can cost several hundred dollars. Multipoint thermocouple recorders, although less expensive per point, are slow and difficult to interpret when many points are involved.

Fig. 1 shows how the cost formula fit together. For thermocouples, the cost crossover point at which scanning and monitoring are equal (cost-wise) might be 100 points. In other words, below 100 thermocouples it may be less expensive to buy single or multipoint recorders or monitors, and above 100 points it would be less expensive to buy a central scanner. The required speed of scanning influences the selection of the approach; practical scanning systems are capable of scanning 5 points/second, i.e. 100 points every 20 seconds.

A monitoring system will duplicate the equipment shown in Fig. 2 as many times as there are thermocouples. A scanning system will only duplicate the input and output devices (thermocouples and alarm lights) as shown in Fig. 3. The alarm detection amplifier will be present only once and there is need for only as many alarm set voltages as there are different

Abstracted from a talk presented at the Texas A&M 14th Symposium on "Instrumentation for the Process Industries," January, 1959.

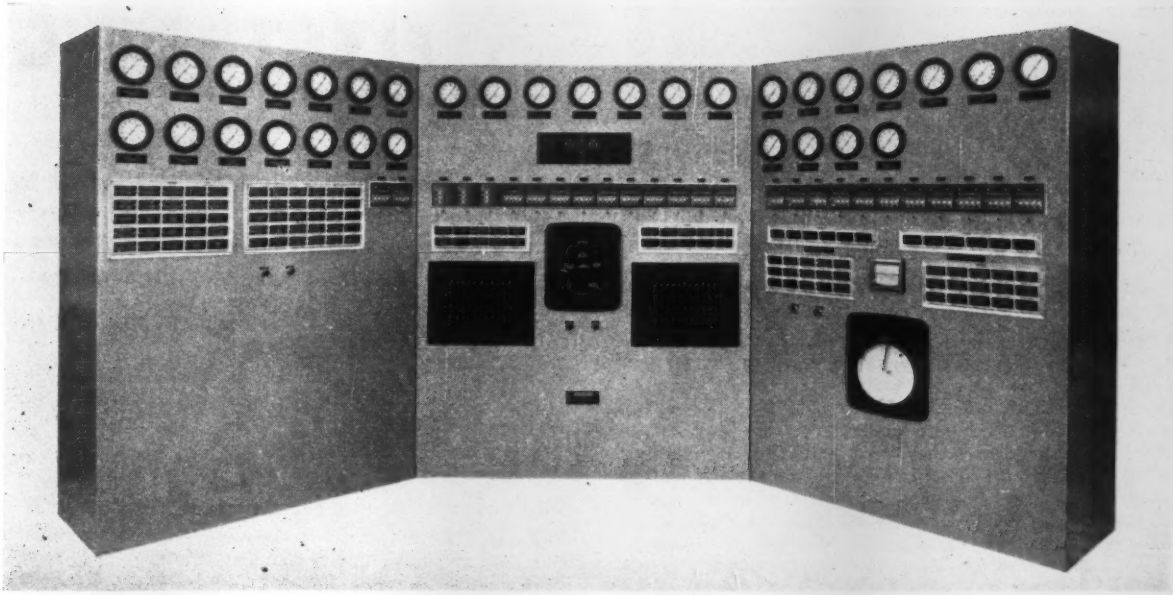


FIG. 4. SCANNING AND ALARM system of the La-Gloria Oil and Gas Company.

alarm settings. Beyond this there will be a certain amount of central equipment necessary—cubicle, power supplies, sequencing logic, etc. (Fig. 4). As all central equipment is shared by all points, it is economical to use the best components and subassemblies available. If necessary, duplicate equipment can be used to insure greatest reliability. Obviously, another $300 to improve the performance and reliability of one amplifier (thus improving the performance for all points) is not going to seriously affect a $30,000 price.

A Typical Problem and the Scanner that Solved it

The economics of scanning are seen clearly from the experience of the LaGloria Oil and Gas Company. Up for consideration in 1955 was a new unit that could be added to existing facilities at their Falfurrias, Texas, gasoline plant to improve efficiency in extracting ethane and propane. The question was whether the new unit would yield a fair return on the investment.

Company management felt the answer lay in some form of automation so that the four men per shift (two compressor operators and two oilers) who operated the existing compressor and absorption area could work the new unit as well. Analysis and time study showed that if engine-compressor troubles could be "spotted" automatically in advance, and if engine temperature and speed data were automatically furnished, no new personnel would be needed.

These requirements were met by the Foxboro alarm scanner shown in Fig. 4. The left panel gives information on the new Ethane-Propane Recovery Section through indicating receiver gauges, annunciators, and graphic diagrams of the engines. The center panel delivers information on the Casinghead Compressor Section.

Added to receiver gauges, annunciators and graphics are an indicating digital tachometer for all compressors and several pumps, a scanner control and test panel, and a Dynalog Temperature Indicator with key switches for precise measurement of individual temperatures. The panel at the right monitors the High-Pressure Gas Compression and Absorption section. Equipment includes receiver gauges, graphics, operating indicators for the dehydrator units, annunciators, and a recorder logging water content (in pounds per million cubic feet) of gas feeding to pipelines.

Not only did the scanner make the new unit economically feasible, it has brought results that far exceeded the company's expectations. Engine compressors have been operated more efficiently and with less down time because potential troubles are discovered much more quickly through automatic scanning and alarm. Two power cylinders and pistons were saved when an excessively high exhaust temperature was alarmed and the trouble immediately corrected. Leaking compressor valves have been detected long before they could have been under the previous method. *The compressor operators now have more time to perform their combined duties on the two units than they did previously on the single unit.*

ELECTRONIC

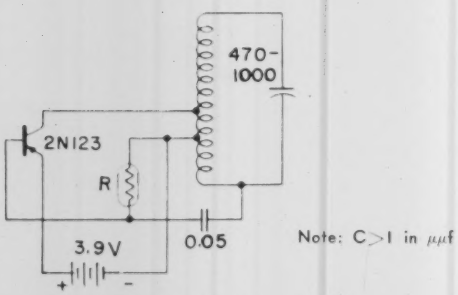
The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

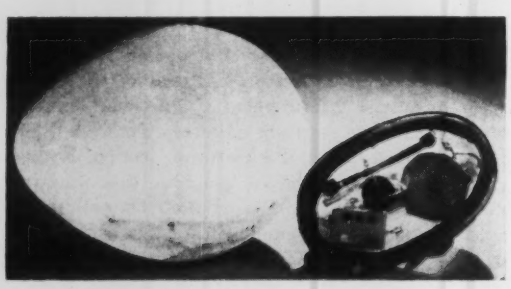
TINY TEMPERATURE TELEMETER IS SELF-BLOCKING OSCILLATOR

This miniature telemetering system is small enough to be inserted in an egg, and was used for studying the temperature of penguin eggs being incubated in Arctic regions. It has also been adapted to human physiology studies (rectal thermometer used in evaluation of sea rescue clothing).

The transmitter comprises a self-blocking transistor oscillator, a temperature-sensitive element (thermistor with resistance of 100K at 25°C), three mercury-cell batteries (Mallory RM-450R), and a multiturn elliptical single-plane directional loop antenna (used as both oscillator coil and antenna). All of this way was only 1″ x 1½″ x 2″ in size, and fitted inside the egg, which then was placed in the nest (with other normal eggs) for incubation.

A single 2N123 PNP transistor is connected in the familiar (vacuum-tube circuitry) Hartley circuit. Thermistor R corresponds to the "grid leak." When the power supply is originally connected, there is no base bias, and a surge of collector current starts oscillations in the tuned circuit. Oscillations are maintained by the positive feedback to the base via the 0.05-uf capacitor. On each negative half cycle at the base, however, base-to-emitter current flows, charging the 0.05-uf capacitor





positively at the side connected to the base. As the time constant of this capacitor and resistor R is long compared to the 20-usec period of a 50-kc signal, a charge on the capacitor builds up until the base is nearly cutoff by positive voltage.

With collector current thus near cutoff, oscillation stops because gain is too low to support oscillation, and the base voltage decays exponentially while the capacitor charge leaks off via the thermistor R. When the base voltage drops sufficiently, oscillation again commences, and the cycle is repeated indefinitely. As the time for the oscillator to recover is proportional to the RC product, changes in resistance with temperature of the thermistor R produce corresponding changes in repetition rate of the oscillatory action.

The oscillator transmits a carrier of about 50 kc, which blocks itself at a rate of 100 to 700 cps, depending on the value of R, which in turn depends on temperature.

In practice, a 2′-diameter loop antenna was mounted on top of a 6′ pole and placed directly over the nest. A transmission line from the loop antenna (and tuner) went directly to a receiver located in a shelter 180′ from the nest; observers remained in the shelter at all times. A counter connected to a receiver indicated the number of times the transmitter blocked itself. (Penguin's eggs were found to remain between 84.5 and 98.2°F despite subzero temperatures.)

Output: Signal could be picked up at distances of 80′ from the nest.

Power supply: 3.9 v, approx. 2 ma drain.

Carrier frequency: 50-kc nominal.

Source: American Electronic Laboratories, Inc., Philadelphia, Pa.; also ONR *Research Reviews*, Navexos P-10, December, 1958.

10-Mc TRIGGER RATE FLIP-FLOP USES SURFACE-BARRIER TRANSISTORS AND "SYMMETRICAL ACTION"

Transistors T1 and T2 in this circuit operate as a conventional transistor Eccles-Jordan flip-flop. Circuit is similar to its well-known vacuum-tube counterpart except for the action of transistor T3, which has no vacuum-tube analog.

Suppose that transistor T1 were conducting. As the voltage drop across T1 is practically zero, base voltage of T2 is slightly positive, and T2 is nonconducting. Collector potential of T2 is about 2.5 v dc. Transistor T3, which is connected between the collectors of T1 and T2, thus has the proper polarity of electrode voltages for PNP transistors. T3 is normally cutoff and conducts when a negative trigger pulse is applied to its base. The resulting collector current produces a positive-going pulse at the collector of T2 and a negative pulse at the collector of T1. This triggers the flip-flop, cutting off T1 and bringing T2 into conduction.

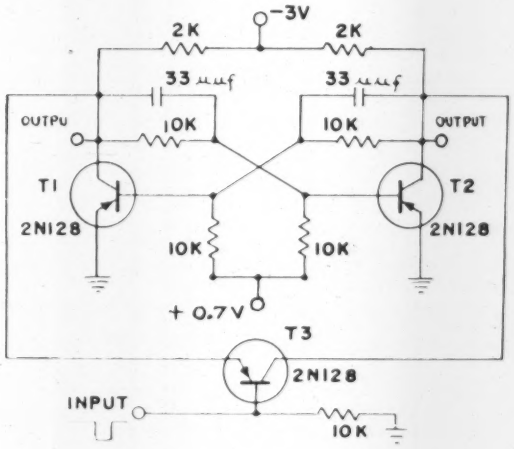
CIRCUITRY

CHARLES F. KEZER

and

MILTON H. ARONSON

T3 is a selected type 2N128 exhibiting symmetrical action—that is, when the collector is made positive and the emitter negative, collector acts as emitter and vice versa. Thus, when a second trigger pulse is applied, current flows in the reverse of normal direction, or from collector to emitter. This produces a negative pulse at T2 collector (conducting) and a positive pulse at T1 collector, again triggering the flip-flop. Standard 2N128 could be used to about 9 Mc; a selected unit to 10 Mc.



Maximum trigger rate is 10 Mc; trigger amplitude is 0.3 to 1.5 v at 0.04 usec width. Output is 2.5 v peak to peak at either collector.

Returning the 10K base resistors to +0.7 v dc as shown was found to improve performance at high ambient temperatures. Originally, tests were made with these resistors returned to ground; the flip-flop became unstable at 38°C. With the small bias added, circuit operated correctly from −55 to +75°C.

Use of 2N393's with higher β and higher current capacity would permit lower collector circuit resistance and more efficient cross-coupling. This would improve the high-frequency performance and permit greater loading.

Input: Negative pulses, 0.3 to 1.5 v amplitude, 0.04 usec wide, 0.02 usec rise time, 0 to 10-Mc rate. (Pulse generators described in "Overlay Method Makes Fast Pulses," *Electronic Design*, May 28, 1958, were used for pulse sources.)

Output: 0 to −2.5 v.

Output rise time: 0.05 usec positive-going, 0.12 usec negative going. (Circuit does not recover completely between triggers.)

Output loading: Depends on switching rate. Will drive 10K ohms in parallel with 33 uuf (full on-off requirement of another 2N128 with 2K collector resistance).

Power supply: −3 v d-c at 1.8 ma; +0.7 v dc at 0.1 ma.

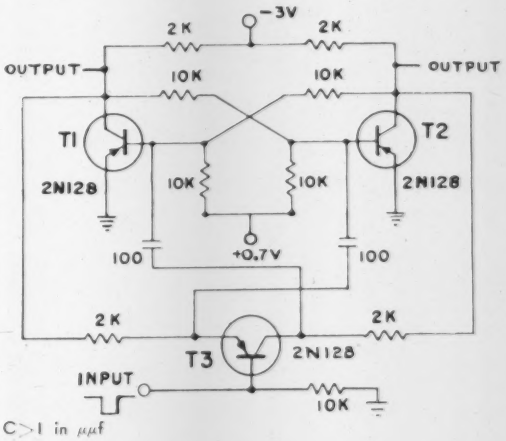
Ambient temperature range: −55 to +75°C.

Source: Mark Smith, Bogue Electric Mfg. Co., Patterson 3, N. J.; also *Electronic Design*, Oct. 1, 1957.

3-Mc FLIP-FLOP HAS 0.05-USEC RISE AND FALL TIMES

A modification of the preceding circuit, this Eccles-Jordan flip-flop also uses "symmetrical transistor operation" for triggering. Transistor T3 is connected in this circuit to apply triggering pulses to the bases of T1 and T2.

Transistor T3 operates in a symmetrical manner as described in previous circuit; two load resistors (2K ohms) are added to develop pulses which are "steered" to each base via the 100-uuf coupling capacitors. A positive pulse is developed at the base of the conducting transistor



(to switch it off), and a negative pulse is developed at the non-conducting transistor (to make it conduct).

The "speedup" capacitors (from collector to opposite base) of the preceding circuit are omitted because the 100-uuf coupling capacitors have similar action. Improvement in the negative-going fall time is attributed to omission of the speedup capacitors.

Max rate: 3 Mc.

Input: Negative pulses, 0.3 to 1.5 v amplitude, 0.04 usec width, 0.02 usec rise time, 0 to 3 Mc repetition rate.

Output: 0 to −2.5 v.

Output rise and fall times: 0.05 usec.

Output loading: Can drive impedance of at least 10K ohms and 33 uuf in parallel.

Ambient temperature range: −55 to +75° C.

Power supply: − 3 v dc at 1.6 ma, +0.7 v dc at 0.1 ma.

Source: Mark Smith, Bogue Electric Mfg. Co., Patterson 3, N. J.; also *Electronic Design*, Oct. 1, 1957.

A NEW SERIES

Process Control Systems

FRED D. MARTON, Instruments Publishing Company

AUTOMATIC SELECTION OF ALTERNATE STEAM SOURCES USES SIMPLE CONTROLLERS

Utilization of waste steam is an economic way of heating a plant. However, it is available only as long as the source of the exhaust steam is in operation. After working hours, and on Sundays and holidays, live steam may have to be used.

Automatic changeover from the exhaust steam of a drop hammer to a high-pressure steam line is accomplished in this system by using 3 non-indicating pressure controllers, a pneumatic snap-acting relay, 2 control valves, and a solenoid valve in the air line.

This system automatically selects the 30-psi exhaust steam when it is available, or the 150-psi steam when the former is not available. It also reduces either source to the desired 15-psi pressure for the use in heaters. Further, it blocks the exhaust line when the high-pressure line is in operation so that steam cannot reach the remote hammers when they are not in operation, where condensed water could cause damage.

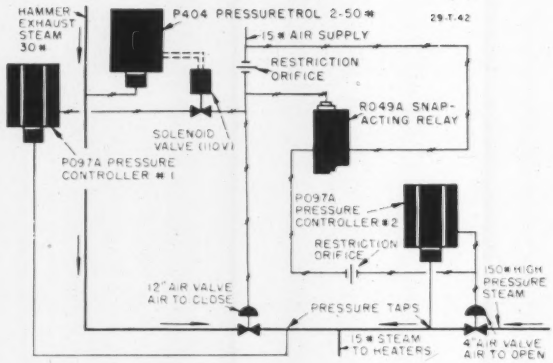
The system is based on use of two simple Pressure Controllers which are essentially flapper- nozzle units with proportional band adjustment (Model P097A, shown).

The flapper-nozzle-type pressure controller is essentially a simple variable orifice in which the orifice is controlled by a pressure-sensitive bellows. By using a restriction orifice ahead of this simple controller, a pneumatic signal proportional to any given pressure can be obtained in economic manner.

Normally, when exhaust steam is available, the mercury-switch-type pressure controller (Pressuretrol Model P404) keeps the solenoid valve open, and the pressure in the pneumatic line following the restriction orifice depends on the orifice in Pressure Controller No. 1. This controller orifice is controlled by a bellows fed from the heater line, and thus the heaters receive a constant 15-psi steam supply from the exhaust steam.

Meanwhile, there is no air supply to the 4″ valve system, and this valve is closed. However, when the hammers shut down, the exhaust steam pressure drops. This causes the mercury switch in the Pressuretrol to close the solenoid valve, raising the pressure in the line to the 12″ valve and closing it.

This increased pressure in turn causes the Snap-Acting Relay (Model R049A) to switch the air supply through the second restriction orifice to the 4″ air-to-open valve, which opens. The pressure in the heater

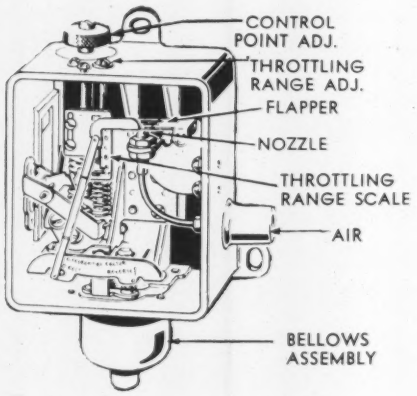


line is once more controlled by a simple flapper-nozzle controller (No. 2) whose orifice, in series with the restriction orifice, develops a control signal proportional to the desired steam pressure.

The R049A relay requires a reversal of about 2 psi to snap from one position to the other. The output steam pressure is adjustable between 4 and 17 psi.

This system is an example of what can be accomplished by the simple "orifices-in-series" principle, whereby a variation in one produces a proportional-output pneumatic signal.

Source: Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Phila. 44, Pa., also *Industrial Control News* Vol. 1, No. 6.



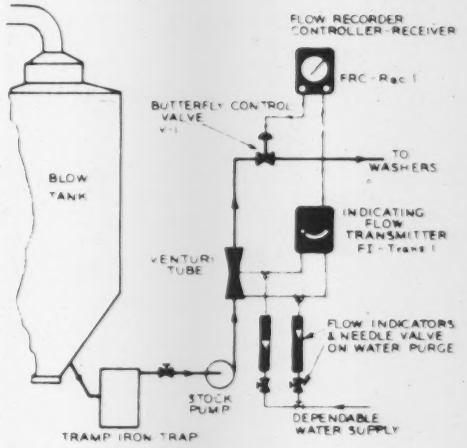
PULP-STOCK FLOW CONTROL

A method for control of pulp stock flow between a blow tank and wash room uses butterfly valves as final control elements. The controller receives the flow rate signal developed by a Venturi tube between the stock pump and the washers. A continuous water purge prevents the pulp fibers from clogging the impulse pipes from the Venturi.

Venturi tubes can replace positive-displacement-type stock meters and save on space and overflow piping required previously. The flow recorder can be calibrated in gallons per minute, pounds per hour, etc., and can include an integrator to show total flow of stock.

Equipment used: FI Transmitter is Model BF13A-1; FRC is Model IA500CW2 with proportional and reset; purge system is conventional, with differential regulators (not shown); Venturi tube throat is Type 304 stainless steel to prevent erosion.

Source: The Bristol Company, Waterbury, Conn., also Application Data Sheet No. 073.8.2-2.



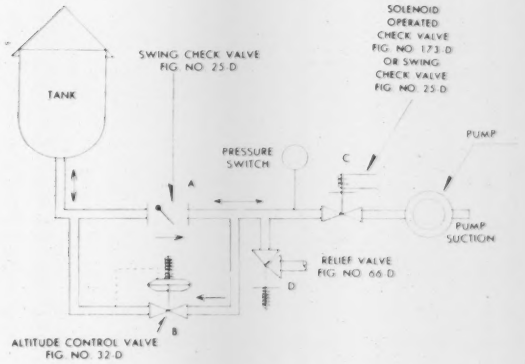
EMERGENCY-WATER CONTROL FOR FIRE PROTECTION

Safety engineers in manufacturing plants are concerned with the problem of an emergency water supply for fire protection or as a standby, should an emergency in the regular water system occur.

A good solution of the problem is provided by an elevated storage tank. Level in the tank can be controlled by one altitude control valve (a pilot-actuated regulator). It can be connected to have a single-acting or a double-acting sequence, depending on whether the discharge to distribution passes through the same line as the supply (double acting, see D), or whether a separate line or a bypass around the valve are used (single acting, see A, B, C).

In the circuit shown the single-acting altitude valve (Fig. 32-D), placed in the upstream pressure line, maintains a uniform water level within a range of 3″ to 12″. The valve is of the globe type with a hydraulic differential (unbalanced) piston which prevents shock under varying flow conditions of high pressure. It has V-shaped ports (saw tooth) to avoid the consequences of surges. The valve is built for underground installation to give it frost protection. It opens to full pipe-line area and is drop-tight when closed. It can be equipped with a switch for automatic shut down of pumps on high water level.

Start-up of pump can be by this same switch (not shown), where tank water is used exclusively for fire protection, or by a pressure switch in the line (shown). A *check valve* (solenoid-operated type or swing) and a *relief valve*, complete the system. Both are shown at right. Use of *block valves* before and after the altitude and by-pass check valves is advisable for maintenance.



A cushioned swing check valve in a by-pass line (left) provides for return flow from the elevated tank to the system. It has an external cushion chamber with a piston held down by a counter-weight. This feature also prevents shock and hammer in the line.

Source: Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.

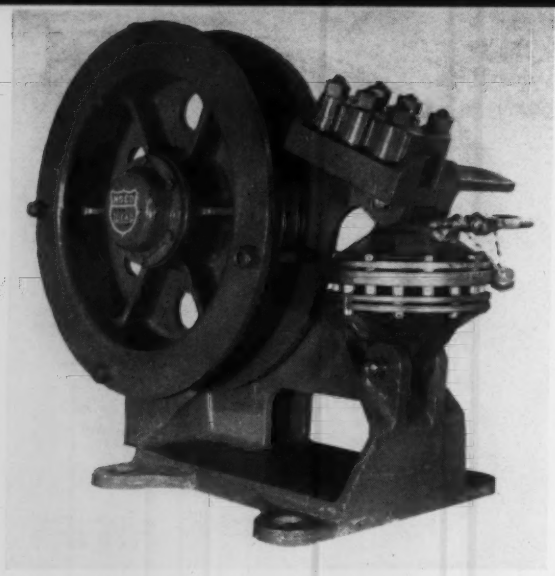


FIG. 1. **ANCHOR** and restraining load cell. Torque on wheel acts to lift top of load cell.

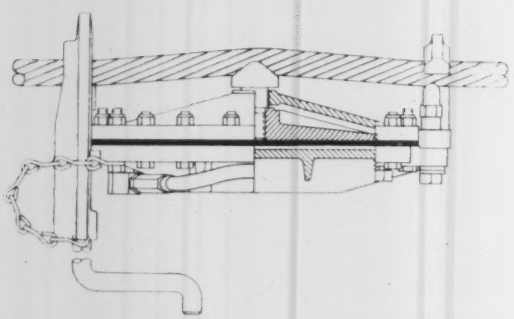
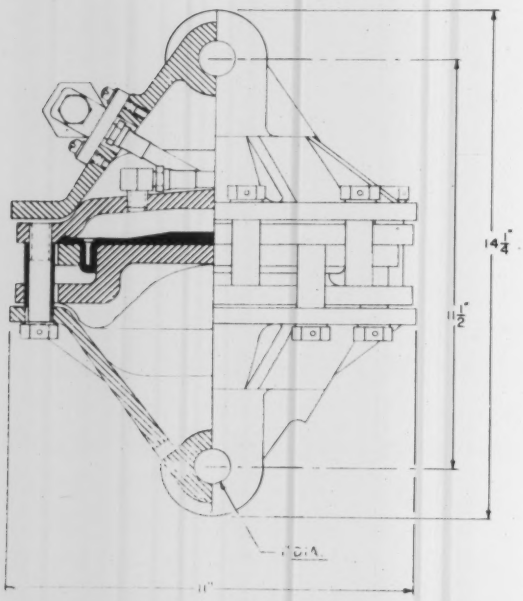


FIG. 2. **EARLY** hydraulic load cell.

FIG. 3. **TENSION** load cell used in anchor shown in Fig. 1.



Hydraulic

Development of the hydraulic load cell in force and load measuring systems.

THE TERM "Weight Indicator" in oilfield drilling commonly refers to the hydraulic system used in the oil fields to control the amount of weight on the rotary drilling bit during the drilling operation. The development of this equipment started over thirty years ago, and it has remained a hydraulic system despite repeated efforts to develop and substitute others. Over eighty-five percent of the weight indicators on drilling rigs today are Martin-Decker hydraulic systems (Fig. 1).

About three years ago the hydraulic tension cell which had been developed for the oilfield weight indicator was applied to other force measurement and weighing applications. At this time Martin-Decker added load cells to its line of cable tension and crane weight measuring devices. These compression and tension load cells are rapidly gaining popularity wherever forces are measured and controlled. This article sketches the development of the hydraulic load cell and describes some of the available hydraulic load measuring systems.

Development of the Hydraulic Load Cell

The early oilfield weight indicator consisted of a cell which was clamped directly onto the dead line of the hoisting system (Fig. 2.) The tension in the deflected line exerted a load on a diaphragm, and the pressure induced on the fluid contained in the cell deflected a Bourdon tube inside the weight-indicating gauge.

It has been customary in this application to use two pointers on the gauge, each driven by its Bourdon tube. One pointer indicates the total weight on the hook over 360 degrees of dial capacity; the other is driven at four times the weight-pointer speed and is used during the drilling operation to indicate the weight on the drilling bit. The deflected-line system was relatively inaccurate (being subject to appreciable error due to temperature change), and the scale was not linear because the deflection angle depends on the line tension. This type system is still used, however, in oilfield operations where accurate weight

Presented at Fourth International Automation Exposition, New York, June, 1958.

Load Cells

R. C. MCNEILL
Martin-Decker Corp.

measurement is not so important as receiving an indication of weight change.

Now the dead end of the wire line on an oilfield drilling rig is wrapped around the drum of an anchor and the low-tension side of the line (which comes from a reel) is clamped (Fig. 1). The line is moved to avoid wear points and it is cutoff periodically at the hoist drum according to a schedule based on ton-mileage. The idea of allowing the anchor drum to rotate slightly about an antifriction pivot so as to enable the line force to be transmitted to a restraining load cell was conceived. The development of a suitable cell, accurate, rugged and reliable, was begun.

The oil-field application imposes severe requirements on a load-cell system. It must be accurate but readily disconnected by untrained men whenever the rig is moved; the signal must be transmitted from the cell to the gauge, but the system must be self-sustained; it must be able to withstand severe shocks and vibrations; the sensitivity must be easily adjusted to suit the operation; and finally, it must be reliable without attention since the cost of running a drilling rig prohibits any instrument calibration or maintenance time.

The Modern Hydraulic Load-Cell System

The hydraulic load-cell system can meet these requirements. The load cell which has been developed to perform this task contains a molded diaphragm which has a rolling section that allows the cell to stroke with negligible friction (Fig. 3). The diaphragm is constructed of Buna-N rubber structurally supported by laminated nylon tapes which are diametrically arranged. The cell is essentially comprised of the diaphragm, a pressure plate underneath the diaphragm, a casing member which contains the hydraulic fluid, and a retainer ring which fastens the diaphragm to the casing and supports the rolling section. In the tension application of the cell (as in this case) the bolts from each outside cover pass through the near plate and fasten to the far plate so that the pressure plate and casing are forced *toward* each other by a tension force (see Figs. 1 and 3).

The heavy-duty diaphragm used in the "E-80 Sensater" cell withstands a test pressure of 5500 psi. However, the working pressure is held to 1800 psi in the fail-safe compression application and, because of safety considerations, it is held to a lower value in the tension cell.

Industrial Applications

The trouble-free experience encountered during the initial years of this oilfield application prompted the design of cells for other applications. The accuracy of some of the systems using this type of cell was found to be within the general 0.1% requirement for scale certification. Therefore, a series of certified crane scales was constructed and offered to industry. This scale is the only crane scale of its size to receive certification in the states of New York, Pennsylvania, and California.

The tension cell used in general industrial applications is nearly identical in construction to the "E-80" cell originally developed for the oil-field application. The hydraulic pressure signal is transmitted through a high-pressure flexible hose to the gauge or other receiving device. The receiving devices used with these systems to date have included pressure switches for safe load warning, a selsyn transmitter and receiver set for long distance transmission, a transducer with and without recorder, the torque gauge of a dynamometer, and the load portion of an integrating device (which is initially being developed to integrate the ton-miles accrued during the use of a wire line on hoisting equipment).

Types Available

The full-scale capacity of these load-cell systems ranges from 60,000 down to 500 lbs. The small load cell has been developed primarily for use in dynamometer applications; however, the variety of its applications is unlimited. One use will be in conjunction with the integrating device (ton-mile meter); this cell will supply the force signal to this device to integrate ton miles in systems such as the passenger elevator.

The Future

It is anticipated that the integrating device being developed as a ton-mile meter will be offered for application such as the continuous weighing of materials flowing over a conveyor system. The accuracy of the integration will be about ±2%. The principle used in this integrator also may be employed to integrate more than two variables. Later development work may lead to the availability of systems to be used for this purpose.

Currently, development work is being concluded on multi-cell weighing kit. In this application three or more cells may be used to support a compact portable platform. The hydraulic signals are transduced and the transducer outputs are then integrated electrically. The accuracy of the system will be better than 0.5%.

The transducers have an unvibrated accuracy of better than 0.5% and are available with damping control. The Selsyn transmitter which soon will be available is similarly constructed; the accuracy of this system at 400 cycles can be held to better than 0.25%

These load cells can be used in myriads of applications to supply the primary signal in automation systems wherever forces are controlled.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

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FIG. 1. VARIABLE-AREA flowmeter.

Metering Hot Fluids

GEORGE R. KELLER and **PARIS H. STAFFORD**
Autonetics, A Division of North American Aviation

A survey of existing techniques for measuring flow rate of hot fluids, with discussion of limitations and possibilities.

ACCURATE MEASUREMENT of flow rate of hot fluids is a formidable problem. Aircraft are now flying at speeds such that the hydraulic fluids get very hot.[1] Despite the difficulties inherent in measuring flows under these conditions, the dynamic requirements of control servos, the time limitations on speed brake and rocket pod extenders, and the accurate control of a host of velocities require accurate measurement of the flow rates of fluids at temperatures up to 700°F.

Flowmeters usually have been calibrated by timing the flow into a container and weighing it. This method has drawbacks even at normal temperatures. It assumes that the flow is absolutely uniform over the period timed; otherwise the calculated flow is merely an average of the observed flows. Spilling, starting and stopping represent some of the sources of errors. High flow rates create handling problems and limit the length of timed flows.

These problems are magnified and other difficulties are added when the fluids are hot. The hot fluids are safety hazards; splashes result in burns; the fluids emit gases which are unpleasant and may have toxic after-effects. Often calibrations must be made at temperatures above the flash point of the fluid, occasionally they are needed above the fire point, and sometimes even above the autogenous ignition temperature of the fluid. Under such conditions, the fire hazards are such that personnel and equipment are in real danger.

Despite these difficulties and hazards, the need for the accurate measurement of flow at elevated temperatures has driven some people into calibration of flowmeters by the bucket-and-weigh method[2] at temperatures up to 400°F. Recently, however, flow measuring devices which should not require calibration by the classical technique have appeared on the market. A look at the more familiar techniques and at the new devices may be appropriate to an understanding of the problems of flow measurement at elevated temperatures.

June Meeting: Thursday 18th, Rio Hondo Country Club, Downey, California

Technical Program: To be announced.

Variable-Area Meters

The most familiar flow measuring device in aircraft work is the variable area meter (Fig. 1). A weighted, sharp-edged disc is allowed to move up and down in a tapered glass tube under the influence of fluid flow through the tube. Markings on the tube relate the position of the disc to flow.

Such flowmeters are simple to use and easy to read.

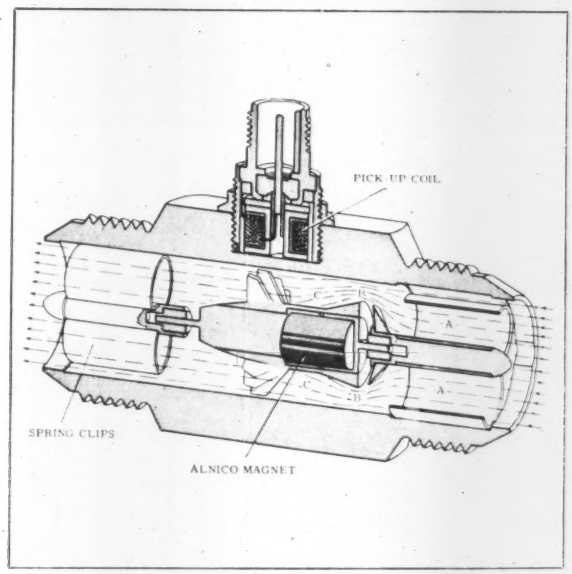

FIG. 2. **TURBINE-TYPE** flowmeter.

FIG. 3. **CONTROL CABINET** of flow analyzer.

However, even with accurately tapered tubes and carefully machined discs, inaccuracies can develop unless the disc is always concentric with the tube. As with any orifice device, the pressure drop varies directly with mass density of the fluid and the square of the flow rate, and inversely with the square of the orifice area. The orifice coefficient is also affected, in a distressingly nonlinear fashion, by both Reynold's Number and the size of the orifice. Hence these flowmeters must be calibrated carefully for each fluid to be used, for every temperature range expected, and for the full band of flows to be measured.

If such calibrations are made, the variable-area meter can be used for steady flows at low pressures. The glass tube so limits pressures that these flowmeters are usually used in return lines or other low-pressure portions of a hydraulic system.

Variable-area meters employing all-metal tapered tubes with remote reading indicators or extension-type direct-reading scales are available for high-pressure application. However, this generally results in a decrease in accuracy or resolution. If the flow rate is not steady the dynamic viscous damping provided by the disc prevents accurate measurements. In fact, if the flow varies sinusoidally, the disc provides a good measure of the rms value of the flow. When the flow varies aperiodically, no good correlation exists between measured and actual flow values.

Turbine Meters

Turbine-type flowmeters have received much use recently. As the flow to be measured passes through an axial turbine wheel, the wheel is caused to spin. The spin rate is then related to fluid flow.

Because all of the parts can be made of metal, the turbine flow meter can be compatible with both high temperature and high pressure. Friction on the spin bearings is minimized by balancing the pressure drop across the turbine against pressure forces developed by the contour of the flow path. Turbine spin rate is measured by detecting the passage of a magnetic field developed by a permanent magnet (Fig. 2). The strength of the field can be averaged and presented in analog form on a voltmeter, or the number of passages of the field can be detected over a known time period and presented in digital form on an EPUT meter.

The turbine devices represent a major improvement in flow measuring devices. They are not restricted to the low-pressure portions of the hydraulic system, they can be made of materials suitable to high temperatures, and their electrical outputs are convenient when permanent records must be maintained. However, the turbine flowmeter still retains some of the more undesirable features of the variable-orifice meter.

As the turbine depends for its operation on the development of a pressure differential across the blade, many of the variables and nonlinearities which plague orifice meters are equally bothersome to turbines. Therefore, calibration over the full range of operational parameters is necessary before much credence can be placed in the accuracy of the readings.

Owing to the hazards mentioned earlier, however, a turbine meter which can be used at 700°F certainly cannot be calibrated by the classical technique at that temperature. So far, the best solution to this difficulty

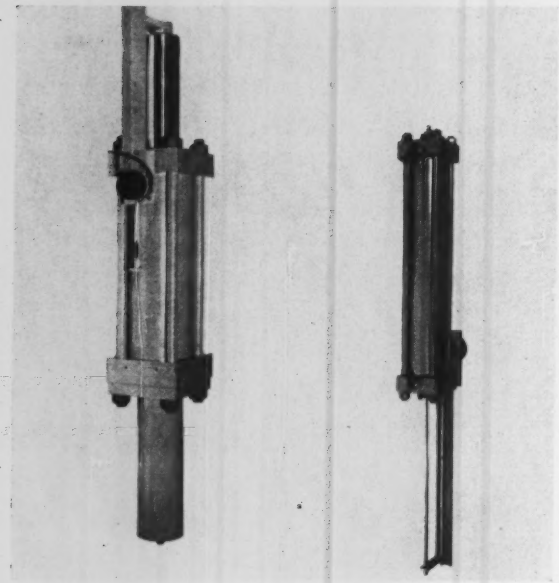

FIG. 4. SPECIAL LOW-FRICTION actuators receive flow from servo valve under study.

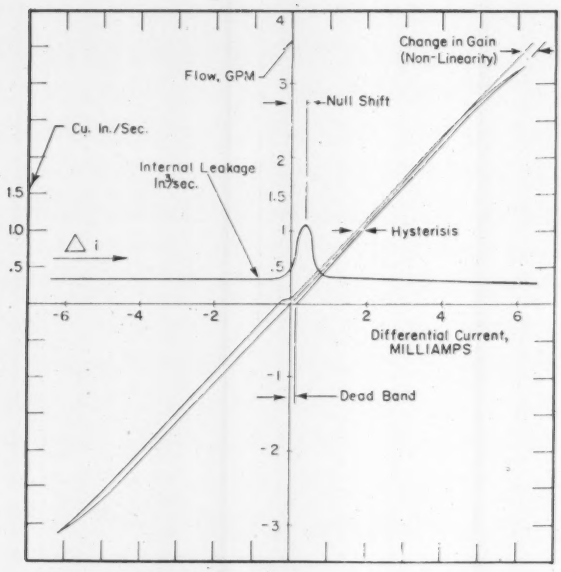

FIG. 5. TYPICAL SERVO flow plots made by measuring displacement of actuator piston.

has been to place a turbine meter, a cooler, and a calibrated flowmeter in series. The high-temperature fluid passes through the turbine and then is cooled to a temperature within the calibration band of the second flowmeter. By making corrections for changes in specific volume, a moderately accurate secondary calibration in terms of the second flowmeter can be achieved.

Such a secondary calibration does not have as high a confidence level as a direct calibration. Nevertheless the secondary calibration is a reasonable procedure.

The turbine meter is little, if any, better than the variable-orifice for measuring non-steady flows. Both the inertia of the turbine and the viscous damping provided by the blades contribute heavily to an inability to follow rapidly changing flows.

Flow Plotter

The rising importance of electrohydraulic servo controls in aircraft and missiles demands a device for measuring the flow output, steady or oscillatory, of servo valves. A simple, unique device for handling this problem has been made available commercially. This device may find wide use for many high-temperature flow measuring and flow calibration tasks.

In its initial form, the device is a servo analyzer. Fig. 3 shows the console of a unit. A ramp signal or other signal form is impressed on a servo valve. The flow from the servo valve is directed into a cylinder with a piston designed especially for low friction (Fig. 4). Displacement of the actuator piston is measured and plotted automatically and continuously against values of the input signal. The device is sensitive; the gain, linearity and hysteresis of the servo valve are displayed clearly. Fig. 5 shows a plot of flow through a servo control valve. Techniques for evaluating hysteresis and linearity are shown. The other curve in Fig. 5 shows internal leakage in a servo valve when the load ports are blocked. This curve is a measure of the flow inefficiency of the servo valve.

Flow Rate Meters

While the servo analyzer is clearly not a "flowmeter," little modification is required to measure flow rate—two possible techniques are (1) put a velocity pickup on the cylinder or (2) differentiate, as a function of time, the displacement signal from the cylinder. The latter usually provides a more accurate reading.

Fig. 6 shows the electronic readout unit of such a flowmeter. As the actuator moves in response to flow, the displacement signal is filtered, attenuated and displayed on the calibrated scales. Several full-scale ranges are available. The direction in which the actuator is moving is shown by "flow sense" lights. Flows ranging from 0.1 gpm to 48 gpm can be measured by using different sizes of actuators. The manufacturer claims an accuracy of one part in 3000.

While limited for continuous flow operations by the necessity of reversing the direction of flow through the actuator at the end of each stroke, the dV/dt meter does have the advantages of being self-calibrating, of being as serviceable at high temperatures as any other portion of the hydraulic circuit, of being usable over a wide range of pressures, and of being broadly insensitive to fluid viscosity or density.

Being a positive-displacement device, the dV/dt

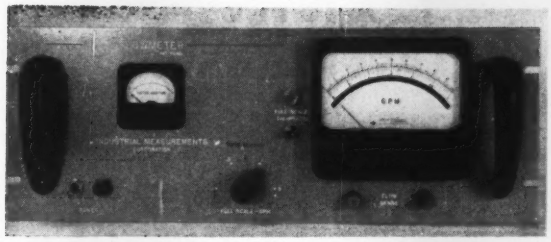

FIG. 6. READOUT PANEL of positive-displacement meter. (Photos 3, 4 and 6 and chart courtesy Industrial Measurements Corp.)

meter can follow and measure unsteady flows over a wide range of frequencies. Actually, the compressibility of the fluid limits the frequency response of the meter more than any other single factor. When used for high pressure, the effect of expansion of the cylinder should be determined and applied as a correction factor if extremely accurate results are to be achieved.

Flow Calibrator

An interesting use of the dV/dt system is the reversal of the controls and readout to provide a known rate of flow for calibrating other flowmeters. By using flow out of the dV/dt actuator and measuring this flow by electric means, an accurately measured flow source is available for checking the calibrations of any other meter. The design, of course, has the same pressure and temperature capabilities as the dV/dt meter.

Conclusions

In the recent past, the inability to measure the flow rate of high-temperature fluids has handicapped the development of the dynamics of hydraulic systems for advanced aircraft and missiles. Devices which rely on known pressure differences for flow determination present such severe calibration problems that accurate assessment of flow rates has not been possible. Measurements of moderate accuracy have been achieved by the use of secondary standards. The problems associated with high temperature, however, seem to demand the development of suitable positive displacement meters. One such meter is now on the market, as has been described. Others could be developed by using the nutating disc principle of the common household water meter.

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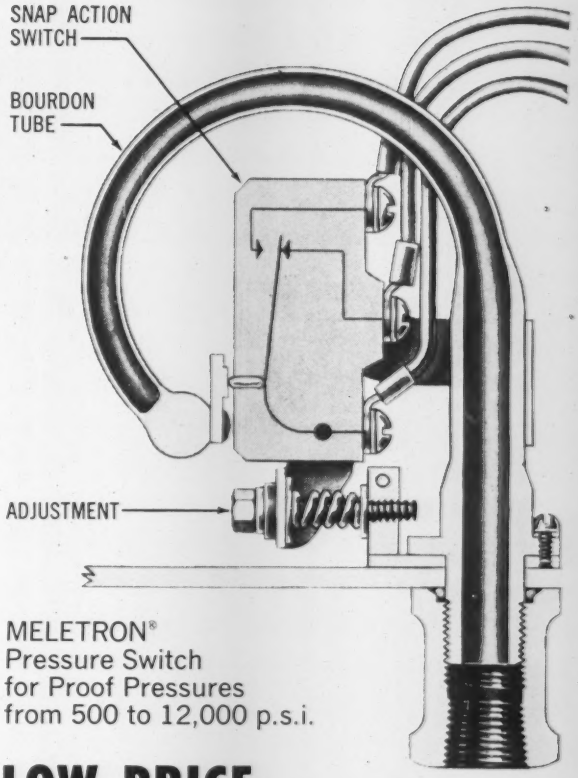
1. Keller, G. R., "Overcoming some of the New Problems in Hydraulic Control", *Automatic Control*, July, 1957.
2. Minutes of Meeting No. 1, Subcommittee A6D, Missile Fluid Power Systems, SAE, Paragraph 3.3.1, Society of Automotive Engineers, New York, N. Y., September 25, 1958.



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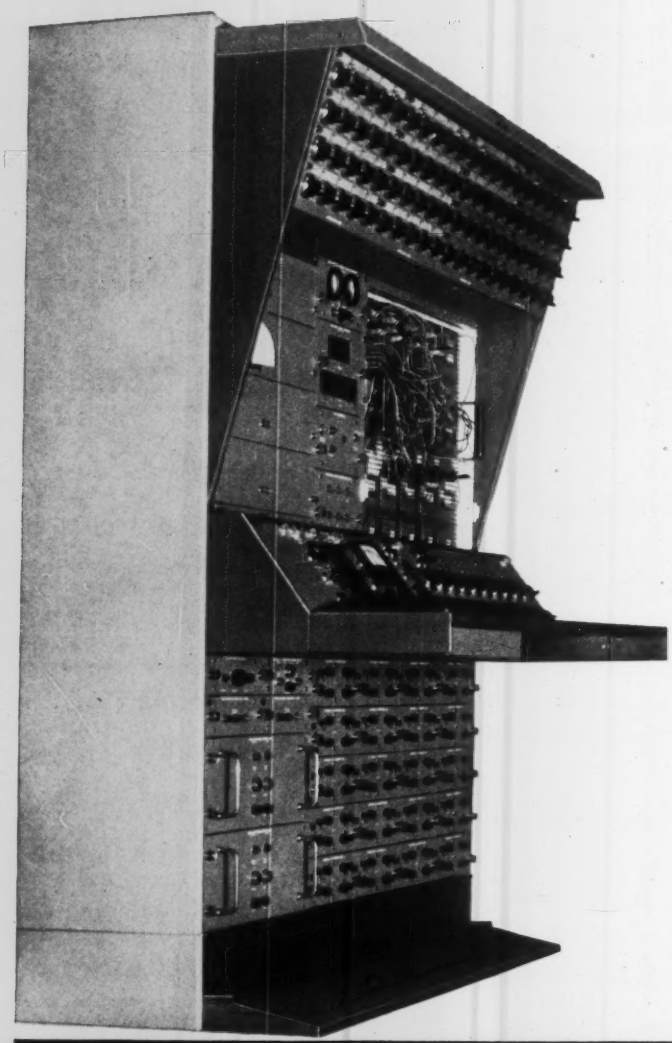

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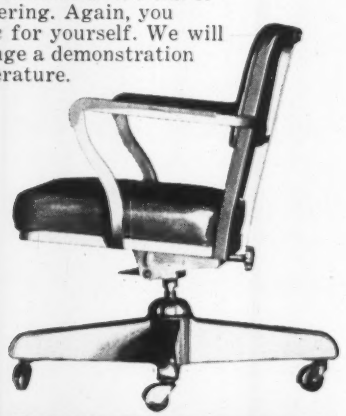

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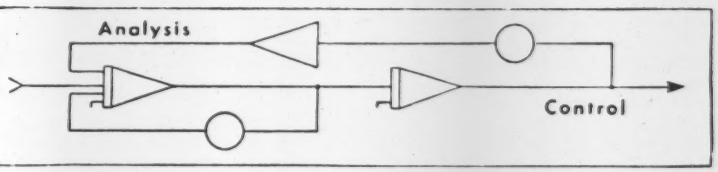

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Bits

It is usually the purpose of this section of the *Newsletter* to give an idea of what is presented in other sections so that prospective readers may get an idea of what to expect and others can find articles to which they wish to refer.

In line with this we can state that this month under Pieces we cover in more or less detail the Southeastern Simulation Council meeting of last October held at the Army Ballistic Missile Agency, Huntsville, Alabama.

Six talks were given at the Southeastern meeting: (1) "Simulation of Flight Paths to the Moon" by *John P. Gibbons* (ABMA), (2) "Experiences with the Bendix Three-Axis Flight Simulator" by *Frank L. Vinz* (ABMA), (3) "Recent Developments in Function Generation" by *John C. McCoy* (ABMA), (4) "New Optical Function Generator" by *Peter Pantazelos* (Hydel, Inc.), (5) "The Guidance and Control Laboratory Simulation Facility at ABMA" by *Fred Digesu* (ABMA), and (6) "Incremental Computers in Simulation" by *David J. Winslow* (ABMA).

Also in this issue under Info, comments on DIAN Laboratories' venture into analog computer production.

A Thot closes the issue.

Pieces

SOUTHERN SIMULATION COUNCIL MEETINGS OF OCT. 30

The Army Ballistic Missile Agency (Redstone Arsenal, Huntsville, Alabama) was host to the Southeastern Simulation Council last October 30th, when six speakers described simulation work with which they were connected.

Dr. O. H. Lange, Deputy Director of the ABMA Computation Laboratory, explained the mission, program, and organization of the Army Ordnance Missile Command. *Dr. Hans Holzer* told of the three-fold responsibility of the Computation Laboratory: simulation, digital computation, and data reduction. The group then made a tour of the analog, digital, and data reduction equipment, the test area, and Fabrication Laboratory.

Gibbons on Flight Paths to Moon

Fred Shaver (ABMA), presided over the afternoon session, at which *John Gibbons* (ABMA) presented the first paper, "Simulation of Flight Paths to the Moon." John explained that a preliminary study of trajectories of a missile in free fall was desired. The missile is acted on by gravities of the earth and moon, and is given an initial velocity that will take it from the earth to the neighborhood of the moon. The idea was to determine the effect of small parameter variations on the trajectories and, if possible, to find the set of initial conditions for which the trajectories were least sensitive to these parameters. As is frequently the case with survey or feasibility studies, a great many tests were required and speed of running and a pictorial result were more important than accuracy. For these reasons a program for solving this problem on an Electronic Associates analog computer was developed.

From a simulation viewpoint these two-dimensional trajectories presented interesting difficulties. The equations generally used to describe the system are not particularly adaptable to the analog computer due to the values of the parameters and the ranges of variables. It was found necessary to make certain approximations and also to use perturbation techniques along with a dual time scale.

The trouble seems to be caused in part by the fact that errors in the position values feed back in a regenerative manner. In addition, very little phase lag can be tolerated in any of the electrical elements used to solve

the equations. As this lag is decreased by slowing the problem down, its effect is increased by allowing the integrators to operate longer. Some of these difficulties were avoided when a program was developed in which the two body "earth-missile" system was reduced analytically in polar coordinates.

The lunar gravitation was then considered as a perturbation of the trajectory—that is, acting as an independent acceleration term on the missile.

Two time scalings were used for each trajectory. During the first part of a run ($r_0 \leqq r \leqq 5.8 \times 10^4$ Km) ten-seconds machine time equal one-hour equation time. For the rest of the run one second equals one hour. The machine must be in "hold" while the changeover of time scalings is made.

The circuit consists of three main portions. The two body problem is solved and transformed to rectangular coordinates. The second part solves for the moon's orbit. It is an ordinary sine-cosine loop. Finally the perturbation equations are solved. The error caused by neglecting the moon's gravity in the early part of the run turns out to be quite small. It is an absolute error and does not affect studies of small variations at all.

The trajectories obtained were reproducible to 0.1 volt (400 Km) or better. Absolute accuracy is probably not very high due to the various approximations made; however, the relative effect of small parameter variations should be fairly accurate. Parameter changes as small as 10m/sec in the initial velocity or 0.3° in the initial angle of attack, when made at approximately escape velocity, caused a relatively large difference, both in the potentiometer settings and in the trajectories.

Details of the problem, including equations and the computer diagrams, were discussed at some length, and two references were given: ABMA DC-TN-215-58, "Simulation of Flight Paths to the Moon" by *John P. Gibbons* and *Frederick T. Shaver;* and ABMA-DSP-TN-2-58, "Some Earth-to-Moon Flight Paths as Simulated by Analog Computer" by *Warren H. Straly* and *Harry O. Ruppe.*

Vinz on Three-Axis Flight Simulator

Frank Vinz (ABMA) next told the group about his experiences with a Bendix Three-Axis Flight Simulator.

As readers of this *Newsletter* may know, the Bendix Three-Axis Flight Simulator is a special device used for causing motion-sensitive components to move with angular velocities and accelerations similar to those of actual flights. One of four existing flight simulators of this type was installed at the Army Ballistic Missile Agency during the period of June to September 1958 to reduce the need for expensive test flights and provide repeatable test conditions—seldom attained in test-flight programs. Perhaps the most important feature of studies with flight simulators is that actual equipment is used rather than approximations of component characteristics.

It may even be possible to establish failure probabilities of certain missile systems by conducting many simulator runs using actual equipment. Error analysis may also be made with many different components to determine effects on missile performance resulting from deviations caused by mass production.

The Bendix Three-Axis Flight Simulator consists of a flight table with pitch, yaw, and roll gimbals and an auxiliary computer for analog simulation and for control of flight table motions. A hydraulic power supply of 3,000 psi, 20 gallons per minute is provided for rotating the flight table gimbals. The maximum acceleration of the pitch and yaw gimbals is 500 radians per second per second while roll is 2,500 radians per second per second. Maximum velocity of pitch is 12 radians per second, yaw is 15, and roll 50. The flight table base is a massive 4,000-pound concrete block for minimizing transmission of table vibrations to the ground.

An advantage of the simulator is the capacity for coordinate transformation which is inherent with the flight table. There are twelve resolver groups which make possible two complete transformations from earth coordinates to missile coordinates and back to earth. An extensive amount of equipment would be required for this if common analog computers using d-c resolvers and amplifiers were used.

Up to the time of Mr. Vinz's report, experience with the simulator had consisted mostly of performance investigations and getting acquainted with the equipment. Needless to say, there were many bugs to be found and exterminated. Some improvisations have been made by ABMA personnel which have resulted in a thorough understanding of particular items. But the many adjustments needed to operate the simulator constitute a real problem. Some time in the future modifications will have to be made to reduce the number of adjustments necessary, to provide more simplified and efficient operation.*

Following the talk, *Dave Prince* (Federal Telecommunication Labs., Atlanta, Ga.) asked whether it is possible to provide linear acceleration with the table.**

Vinz: "This is not contemplated."

Asked about the approximate cost of the table, Frank answered "$700,000."

Some references on the subject:

"The Use of the Bendix Flight Table" by C. M. Edwards and E. J. McGlinn, Bendix Aviation Corp., Research Laboratories.

"Flight-Table Instrumentation" by R. H. Esling, Instruments and Automation, Vol. 29, No. 9, September 1956.

"Instruction Book for the Three-Dimensional Flight Simulator System", Vol. I, Computer Division, Bendix Aviation Corp.

"Three-Dimensional Flight Simulator," Computer Division, Bendix Aviation Corp.

McCoy on Function Generator

An abstract of the third talk, "Recent Developments in Function Generation" by John C. McCoy is reproduced here almost exactly as received, probably because it interested ye Ed., and he is likely to judge the interest of others by his own.

The requirements of the ABMA Computation Laboratory for a function generator are:

Accuracy of 1% of full scale
Repeatability of ½% of full scale
Frequency response of 20 cps
Reversible independent variable
Easily prepared input function
Easy multiplication with another variable

The laboratory is now developing several function generators; none will meet these requirements but each will fill part of the gap between said requirements and equipment that is commercially available.

The first development function generator is one using a commutating switch. This technique has been used before with some success. Major

*It would be interesting to hear the results of their more recent experiences.—ED.

**Humorist!

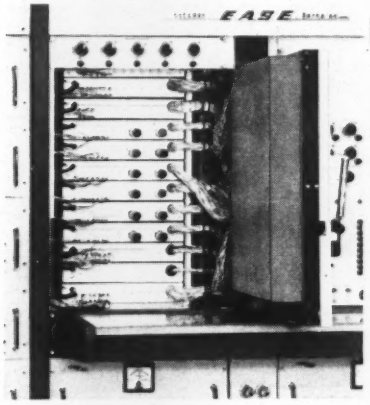
SPEAKING WITH EASE®

An up-to-the-minute report on computer technology prepared by the **Beckman/Berkeley** *engineering staff*

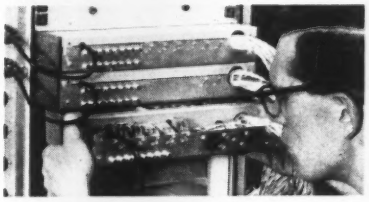
Careful Design Reduces Computer Maintenance Time

The ideal computer, for which we all strive, never breaks down and requires no adjustment. At the moment all economically feasible computers contain some components that may fail and some precision circuits that require occasional adjustment. We must tolerate unavoidable repairs and adjustments, but with proper design we can greatly reduce the time spent at these tasks. Here are some of the techniques used to speed and simplify maintenance on EASE computers.

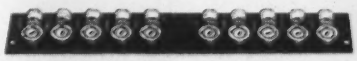
Easy Access to Circuits



The arrangement of patchbay and passive computing elements illustrates the way in which parts are made accessible from the front. The patchbay swings back to expose a bank of oven drawers holding computing resistors and capacitors. Plug-in integrator relays are immediately accessible. The rear shield on the patchbay can be removed quickly to expose taper pin connectors.



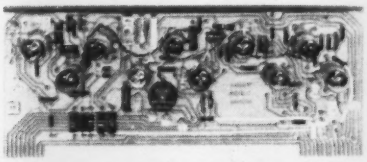
Drawers will slide clear out of the oven without breaking electrical connections made through flexible cable. A drawer can be removed and replaced by a dummy drawer without disturbing oven temperature. Note that the forward lid of the lower drawer has been removed. This exposes other relays for servicing with the drawer in place.



This strip of ten computing resistors can be lifted from an oven drawer simply by removing two screws and slipping off solderless connectors. Spare strips may be stocked for immediate replacement.

Electrical connections to rack-mounted units are made with flexible cable. Cables are sufficiently long so that a chassis can partially be removed for inspection or repair while the unit is in actual operation.

Plug-In Replacement

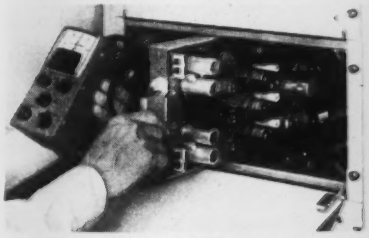


Circuit elements such as the Model 1156 multiplier shown above are built on plug-in modules that can be quickly replaced. Amplifiers, relays, function generators, coefficient potentiometer assemblies and control circuits can ordinarily be removed simply by slipping a plug from a socket.

Independently Powered Units

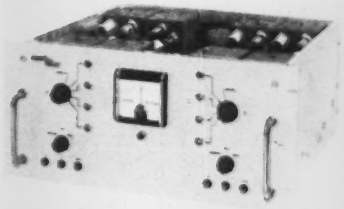
Each rack cabinet in an EASE computer may be switched off for servicing while the remainder of the computer is operative. Plate and filament supplies may be independently applied. After inspection or repairs the cabinet is returned to the control of the master power switch at the console.

Quick, Informative Performance Tests



Using the test unit above, the 4-channel 1148 amplifier module can be rapidly tested in place for drift, open-loop gain, output current capacity and overload alarm. Tests of gain and current capacity enable one to detect and correct possible trouble before the unit fails in actual operation. Other operational components such as multipliers can be tested from the front panel.

Conveniently Located Adjustments



When circuits require periodic attention, adjustment controls are located on the front panel as with this .02% electronic multiplier, Model 1157. Note built-in panel meter for monitoring correct adjustment.

C9

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Bendix G-15

multi-code, high-speed

PAPER TAPE READER

Punched paper tape from almost any device or system equipped with a punch can now be read directly and at high speed into the Bendix G-15 computer. The unique Model PR-2 photoelectric reader accepts paper tapes *punched in any numeric* code by cash registers, accounting machines, adding machines, typewriters, analog-to-digital converters, and similar devices, whether operated manually or as part of an automatic data collecting system.

Applications of the G-15 and PR-2 accessory cover a broad range of data sources. For example, in research there are wind tunnels and engine test stands, telemeter equipped missile and experimental aircraft, and strain gauge and other types of laboratory test systems. In industry there are process monitors and data loggers, production line test and measuring devices, and inventory recorders. In business there are point-of-sale recorders and office machines of many types.

The PR-2 accepts paper tapes of 5, 6, 7 or 8 channels. It reads unidirectionally at 400 characters/second, allowing rapid input of data collected by one or many devices, regardless of their punching speed. It stops on one character, eliminating the need for special spacing following a stop code.

A plug-in matrix may be quickly replaced or rewired, enabling the user to change external codes at will. This matrix transforms the external code into standard G-15 codes and enters the information into the computer. Reel-less tape winding and unwinding facilities accept tapes from most punching devices with minimum handling.

With this new Bendix Computer development, flexible communication between computers and their sources of data reaches a new peak. Rather than modify the data originating equipment to fit the requirements of the computer, the computer can now be adapted in a few short seconds to the characteristics of its data source. For more information on Model PR-2 write to Bendix Computer Division, Bendix Aviation Corporation, Los Angeles 45, California. Department J-12.

For more information circle **86** on inquiry card.

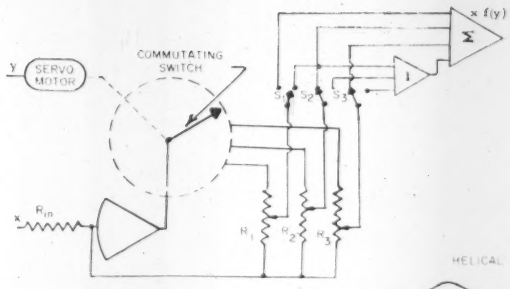
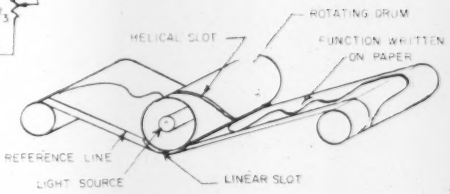


Fig. 1. Commutating switch function generator.



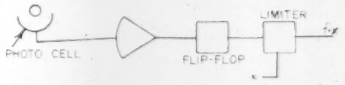


Fig. 2. Mechanical scanning function generator.

advantage of this system is its repeatability so far as amplitudes are concerned. A feature unique to the ABMA version is the use of a shorting type of switch which provides twice as many steps in the output as there are switch contacts.

The commutating switch (Fig. 1) is driven by a servo system so that its position is a linear function of some variable (y). Each switch contact is wired to connect a potentiometer as the feedback resistor of an operational amplifier. The output from the arms of the potentiometers is then proportional to the input of the amplifier (x) multiplied by gain factors proportional to f(y) which are specified by the potentiometer settings. The potentiometer arms are all connected to the inputs of a summer directly or through an inverter for sign changing. When two potentiometers are contacted simultaneously, the current in each is half the normal current, but the output of the two potentiometers is then summed so that the actual output voltage is the average of that produced by the two potentiometers individually. The input x may be a constant reference or a variable, the latter resulting in multiplication of a function by a variable, or xf(y).

The second function generator under development is a mechanical scanning device (Fig. 2). This is a modification of the cathode-ray scanning function generator which has been used successfully for several years. It is hoped that the use of a mechanical scanner instead of the cathode-ray tube will eliminate the problem of sweep linearity.

In this function generator the linear sweep is generated by the intersection of two slots. One slot is cut through the silver-plated surface of a clear plastic drum. The slot follows the curve of a helix of 360° and is 6" long. The second slot is cut axially through a piece of sheet metal curved almost to the radius of the drum. Each revolution of the drum area of intersection of these slots moves linearly across the paper beneath the curved metal sheet. The light source, a 40-watt clear showcase lamp, is placed inside the drum. The spot of light produced by the intersection of the two slots shines through the paper and onto the cathode of a photomultiplier. The spot moves from the edge of the paper and the first opaque line it crosses becomes the reference line. This generates a pulse by means of a phototube. The pulse is then amplified and applied to the "change state" input of a bistable flip-flop to turn the flip-flop on. Similarly, when the spot crosses the opaque function line, a second pulse is generated which turns the flip-flop off. To make sure the flip-flop is off as the spot crosses the reference line, a photo diode is placed 90° from the photomultiplier and adjusted laterally along the axis of the drum until the light hits it a few milliseconds before the spot crosses the reference line. The output of this photo diode is applied to the "off" input of the flip-flop. If the paper is moved beneath the scanning device as a function of the independent variable, the output of the flip-flop is a pulse-width-modulated square wave of the function.

As the foregoing device has not yet been completed, exact measurements have not been made. The following

ARE any new fields of computation opened up by the GPS High Speed Analog Computer?

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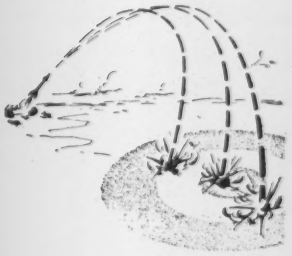

high speed computer such that the solution is carried out several thousand times faster than real time, samples of a random variable such as the miss distance of a missile system can be taken at rates up to 50 per second. Thus, sample sizes of several hundred can be taken in a few seconds' time.

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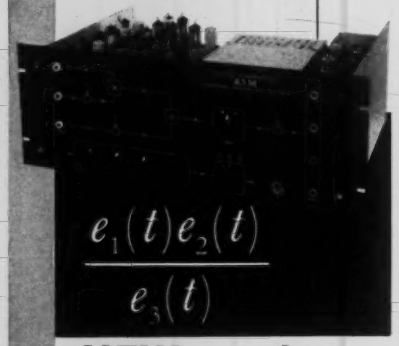

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information is the result of preliminary study.

The signal-to-noise ratio of the light hitting the photocell is determined by granularity of the paper, area of the light spot, and opacity of the function line. A spot size of 0.3 mm^2 seems to give the best signal-to-noise ratio consistent with reasonable resolution. Using unlined paper of about the granularity of graph paper with a ¾-mm-wide function line of draftsman ink results in a signal-to-noise ratio of the light of about five to one. Unfortunately, the light intensity is so low that the electronic noise of the photomultiplier enters into the electrical output. The signal-to-noise ratio of the photocell output is in the order of two to one.

In the first model of this function generator the paper will move to 10 in/sec as a function of time only. The scanning rate of 150 cps permits one to follow a 2-cps sine wave. Static accuracy is in the order of 0.2% with repeatability several times better.

The third function generator under development (Fig. 3) is an outgrowth of the rotating drum device. It would appear that the signal-to-noise ratio of the light beam can be improved by using reflected rather than transmitted light. Scanning is done by a rotating mirror wheel with a mercury vapor lamp providing a high-intensity light source. A spot of light is focused on the paper via the mirror wheel. As the wheel rotates, the spot scans the paper. Reflected light from the paper is reflected by the mirror to a photocell placed near the light source. The first model of this type will use a 3″ wide graph and a 6-sided mirror wheel 4″ in diameter. The speed of the mirror wheel will by 3,000 rpm, which produces 300 scans per second. The spot diameter will be 0.6 mm and should produce an accuracy of about ½% of full scale.

The output of either scanning type of function generator is a pulse-width-modulated square wave which lends itself to several applications. If the output is accurately clamped and fed through a low-pass filter, an analog voltage proportional to the function is the output of the filter. Since the repetition frequency is in the order of 70 times the maximum frequency of the output, very little phase shift is expected in the filter. By making the amplitude of the wave proportional to another variable, the output of the filter is proportional to the product of the function and the variable. These devices can also have an

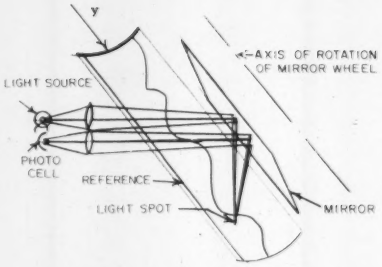


Fig. 3. Rotating-mirror function generator.

interesting application as automatic oscillogram readers. The output of the flip-flop can be gated with a clock pulse generator and fed to a counter. The counter will then total the number of pulses occurring during the "on" time. This means that scaling can be changed by merely changing the clock frequency.

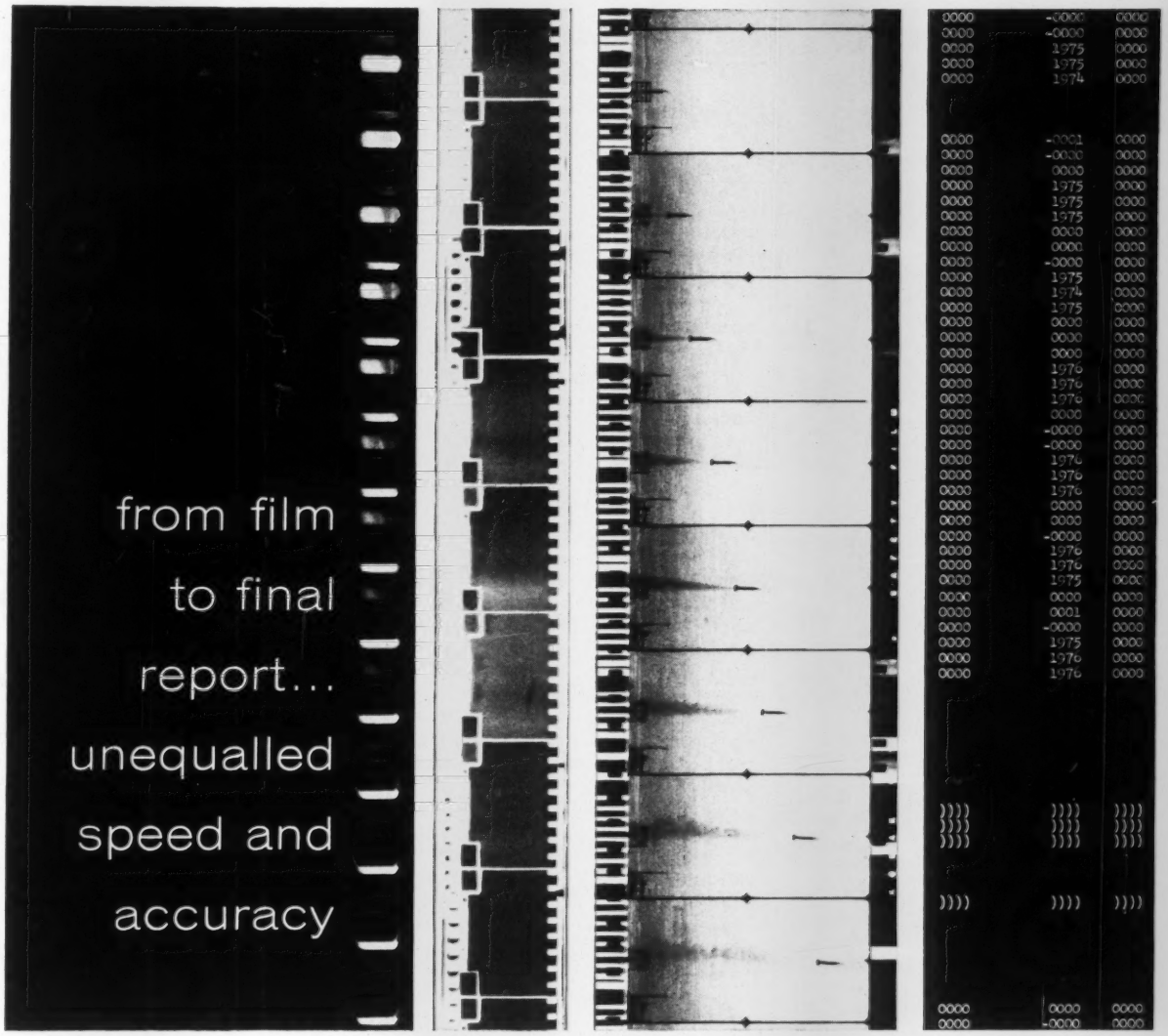
Pantazelos on Optical Function Generator

Fred Shaver introduced the next speaker, *Peter Pantazelos* (Hydel, Inc., Waltham, Mass.), whose paper was entitled "A New Optical Function Generator." According to Ed Holmes's notes, Mr. Pantazelos described a function generator with a scanning system that scans an optical field of light and dark spaces. The output is essentially digital; after taking this output through a counter and through a digital-to-analog converter, an analog output is finally derived. This certainly sounds interesting, but more facts we cannot give. Notes, an abstract, or a text of the talk may exist, but they did not reach your Ed.

At the end of the presentation *Bob Yeager* (Electronic Associates, Inc., Long Branch, N. J.) asked Mr. Pantazelos to describe the optical plate. This we understand he did, in much detail. Wish we knew what he said.

Digesu on ABMA Facility

The next speaker, *Fred Digesu* (ABMA), gave a description of the Guidance & Control Laboratory simulation facility at ABMA. Fred talked about several of the problems with which the G&C Lab is concerned. Basically, they are interested in analysis of guidance systems for missiles flying along a given trajectory. Their method of approach generally uses the perturbation technique to introduce small errors. Many of their difficulties stem from trying to determine whether systems are stable. As their problem solution progresses they try to insert hardware into the system in place of transfer functions.



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Winslow on Incremental Computers

The last speaker, *David Winslow* (ABMA), described "Incremental Computers in Simulation." This paper is tutorial in nature in that it explains the operation of "the digital differential analyzer, or incremental computer"* and traces its development from 1949 to the Packard-Bell TRICE, the present form of which is similar to that of an analog computer in that it consists of individual plug-in operational elements. These units are constructed with etched circuit boards and employ 3-megacycle transistorized circuitry with diode logic and gating. Separate elements are provided for each basic operation—i.e., integrators, summers, constant multipliers, digital servos, function multipliers, and function generators. All communication between these units is via a standard patch panel, with a single control unit serving to coordinate the computer.

The greatly increased speed of computation should permit use of the computer as an active element in closed dynamic systems and make possible its use in a variety of other real-time applications.

Finally, the characteristics of the computer closely approximate the physical system in detail and in sense of operation. This, coupled with ease of programming and ease with which various elements of the problem may be observed, corrected, or varied during the solution, should serve to make the DDA a powerful tool in the hands of the engineer, rather than an interesting but not particularly useful novelty.

The Southeastern Simulation Council meeting concluded that evening in the Huntsville Elks Club, where members were treated to a steak dinner and a talk by *Lieutenant Colonel Bruce Pierce* on the Army Guided Missile Command and its program.

Information (Without Theory)

A communication which set us reminiscing was an announcement that DIAN Laboratories (611 Broadway, New York 12) had developed and is offering the DIAN 120, a real sexy-looking computer as you all know who have seen the color illustrations which have been distributed.

As most of you have probably received these with the specifications, we will not repeat DIAN's qualifications here. We do think you might be interested in some of the background, however.

In late '49 the Bureau of Aeronautics sent one of the early REAC's (the third on the west coast, we believe) to the U.S. Naval Air Missile Test Center at Pt. Mugu. *Stan Fifer* followed shortly to check it out. We didn't know what it was and Stan wasn't about to tell us—he wanted to get back to the Big City. Previously, in 1946, Stan had met *Ben Manfredi* at Reeves Instrument Corporation, where Ben worked on the first REAC and Stan put it to use. In the period up to 1952 Stan was in charge of Project Cyclone (where the REAC was born) while Ben assumed responsibility for the design and construction of the complete Cyclone facility. After 1952 Stan moved west to Hughes Aircraft while Ben went to Mid-Century, where he was responsible for the design of their computer. After Stan returned east*, he and Ben formed DIAN Laboratories in 1955. Their primary activities until recently have been operating an analog computing center and designing special-purpose computers and trainers. DIAN 120 marks their entry into the analog computer manufacturing field. The first unit has been installed in New York City to give them a facility of some 400 amplifiers.

*A DDA is an incremental computer, but all incremental computers are not DDA's —ED.

Thot

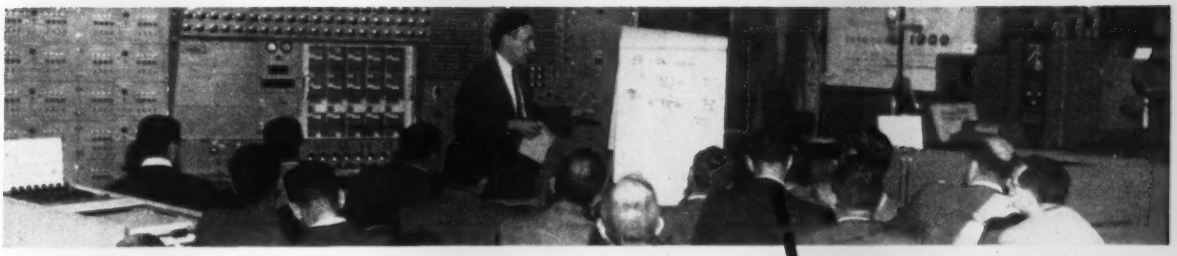
He who is today concerned with designing a better mouse trap just isn't with it; the rest of us are in a *rat race!*

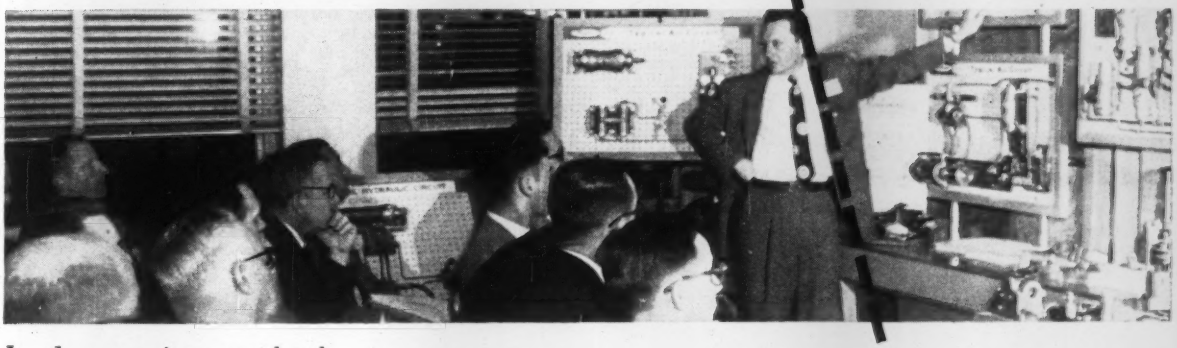
Computer Events

Central Simulation Council

Date: 5 October 1959
Place: McDonnell Aircraft Co., St. Louis, Missouri
Subject: "Computer Environment"

*Just can't stand the uncivilized West!





In the morning, a school . . .

A Show Becomes A School

At an average trade show, the exhibitor reaches any one visitor for only a few minutes . . . perhaps only to get his name. By contrast, the Automation Exposition exhibitor has his best customer prospects in front of him for a 90-minute lecture and demonstration.

The exhibitor can present the most complicated technical and economic analyses in this ample time . . . to as many as 8 classes of 20 to 150 men each . . . while retaining the advantages of an open exhibit with its thousands of visitors!

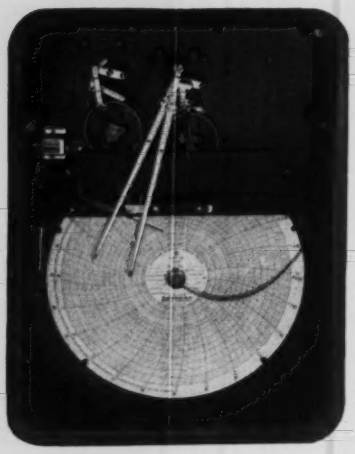
More than 3,000 clinic registrants will pay to increase their understanding of the most modern measurement and control apparatus, military systems, materials handling, and other phases of automation at the Fifth International Automation Exposition in New York City, November 16 to 20, 1959.

An exhibit at the Fifth International Automation Exposition offers this opportunity to you. Advertising and direct mail promotion by the Exposition Management will help develop your classes as soon as your exhibit-clinic room is selected. The earlier you select your space, the larger will be the number of men made ready for your educational-sales effort.

The Second Military Automation Exposition will be held concurrently with the Fifth International Automation Exposition and Congress.

For complete details, contact Richard Rimbach Associates, Management Fifth International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna. N.Y. Office, 525 Lexington Ave., Rm 359, N.Y. 17—telephone Murray Hill 8-0980.

In the afternoon, a show.



AMERICAN®
INTEGRATING
ORIFICE
METERS

American Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

Ask for Bulletin 401 for complete details.

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METER COMPANY
INCORPORATED ESTABLISHED 1836
General Offices: Philadelphia 16, Pa.
Sales Offices in Principal Cities

For more information circle **92** on inquiry card.

new instruments

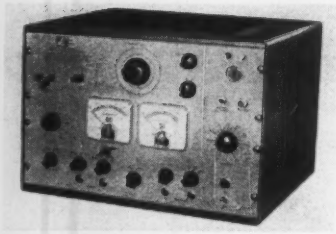
FOR FURTHER INFORMATION USE THE FREE ORDER CARD ON PAGE 793

PHOTOELECTRIC CONTROL

New Model BT1 Transistorized Photoelectric Control requires 10 foot-candles minimum light, with 0.04 sec minimum dark time and 0.04 sec minimum light time. Available with a wide selection of light sources and with miniature remote sensing heads.—*Autotron, Inc., Box 722 Q, Danville, Ill.*

For more information circle **208** on inquiry card.

TRANSISTOR TESTERS

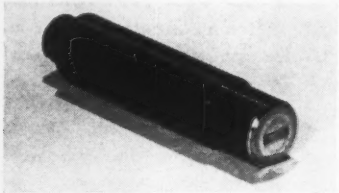


New KP-2 Series of Transistor Test Sets features extended testing ranges for analyzing transistors at frequencies from 100 cps to 200 kc. They offer ranges up to 2 amps, 200 v with two regulated semi-conductor power supplies for bias voltages and currents.—*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

For more information circle **209** on inquiry card.

MEMORY DRUM HEAD

New single-track low-inductance Type HD-9 Memory Drum Head reads and records information at high frequencies. A locking four-conductor polarized plug is used for ease and speed in changing to any desired wiring arrangement. Overall dimensions: length 2.186"; diameter 0.5".—*J. B. Rea Co., Inc., Electronics Div., 2202 Broadway, Santa Monica, Calif.*



For more information circle **210** on inquiry card.

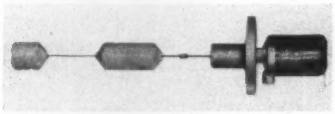
PRESSURE/FREQUENCY TRANSDUCER

New Model PFS-2 Pressure-to-Frequency System combines a specially designed reactance-controlled subcarrier oscillator and a single-coil variable-reluctance-type pressure transducer, for measurement of a wide range of absolute, gage, or differential pressures. Non-linearity does not exceed ± 1%. The low-impedance output circuit can be connected to telemetering transmitters, magnetic tape recorders, or digital tape readout equipment.—*Ultradyne Incorporated, P. O. Box 3308, Albuquerque, N. M.*

For more information circle **211** on inquiry card.

LEVEL CONTROLLERS

New Models A-102-F and A-103-F Level Controllers for flanged mounting, and A-102 and A-103 for screwed mounting, are for specific gravity ranges beginning at 0.5, depending on

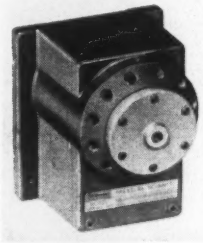


the type displacers used. Displacers can be of glazed porcelain (standard) or Karbate, chemically inert impregnated carbon. Stainlerr steel displacers can be supplied with Model A-103-F.—*Magnetrol, Inc.* 2110 *S. Marshall Blvd., Chicago* 23, *Ill.*

For more information circle **212** on inquiry card.

PRESSURE SCANNER

New SP-101B Pressure Scanner provides an economical means of measuring a multitude of pressures using only one transducer. For ex-

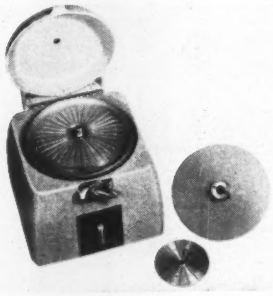


ample, with one SP-101B interrogating 12 others, 144 pressures can be measured by only one transducer. Operational range is from vacuum to 350 psig for dry air and non-corrosive dry gases.—*Datex Corp.*, 1307 *South Myrtle Ave., Monrovia, Calif.*

For more information circle **213** on inquiry card.

HEMATOCRIT CENTRIFUGE

New Model 31 comes with two heads, one holding 36 standard Hematocrit tubes, and a combination head



holding 8 Hematocrit tubes and eight 75 mm x 1.75 mm tubes. Speeds up to 12,000 rpm are obtainable.—*Chicago Surgical & Electrical Co., div. of Labline, Inc.*, 3070-82 *W. Grand Ave., Chicago* 22, *Ill.*

For more information circle **214** on inquiry card.

Welch Duo-Seal® Mechanical and Diffusion Pump Assembly

EACH ELEMENT WITH TWO-STAGE CONSTRUCTION

WATER-COOLED OR AIR-COOLED MODELS

HIGH VACUUM • OUTSTANDING PERFORMANCE

★ GUARANTEED VACUUM—0.001 Micron
(0.000 001 mm Hg)

★ CAPACITY AT 0.1 MICRON—
600 Liters Per Minute

- ECONOMICAL TO RUN AND MAINTAIN
- QUIET OPERATION

$275.00
Complete with Motor

No. 1392 Patent No. 2337849

This is an unusually convenient portable diffusion-pump unit, employing a two-stage mechanical pump and an unbreakable, all-metal diffusion pump. The two components are properly matched as to performance and together will produce a vacuum of better than 10^{-6} mm without the use of cold traps. Complete with oil for both pumping elements.

1392. MECHANICAL AND DIFFUSION PUMP, Water-Cooled
For 115 Volts, 60 Cycles, A.C. Each, $275.00

1392A. MECHANICAL AND DIFFUSION PUMP, Air Cooled.
For 115 Volts, 60 Cycles, A.C. Each, $275.00
For attached Belt Guard, add $15.00 to above prices.

1391. DIFFUSION PUMP, Only, Water Cooled, With Octoil. Each, $106.00

1394. DIFFUSION PUMP, Only, Air Cooled With Octoil. Each, $106.00

1393. MOUNTING PARTS.
For mounting No. 1391 or No. 1394 Diffusion Pump on base of mechanical pump. Set, $3.00

Other combinations are available with speeds of 120 to 6000 liters per min at 0.1 micron. We will gladly submit full details describing the best combination for your particular application.

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Manufacturers of Scientific Instruments and Laboratory Apparatus

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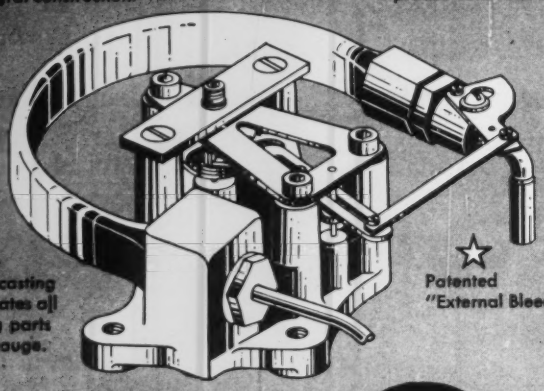
HEISE GAUGES

Permanent positive accuracy of alignment guaranteed by integral construction.

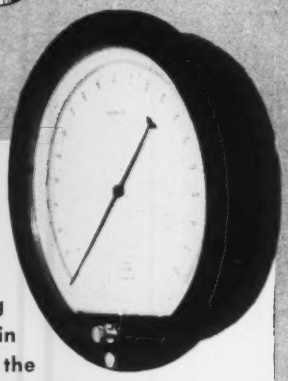
Weldless heat treated Bourdon tube maintains precise calibration.



Massive Bronze casting coordinates all working parts of the gauge.

Patented "External Bleeder"

Dial individually engraved with reference to the pressure gradient of its gauge mechanism.



ACCURACY

The standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Designed to maintain permanently its inherent precision, the Heise gauge is often used in place of the dead weight tester in checking other instruments. Consistently accurate performance as a calibration reference has established its recognition as THE STANDARD OF THE WORLD.

SPECIALIZATION AND EFFICIENCY

Heise Laboratories have always specialized in the design and production of high precision pressure gauges. The highest standards of quality control protect the manufacture and assembly of each component and the permanent calibration of the finished instrument.

Efficiency in the production of one type instrument, precision pressure gauges, has made it possible to maintain a prompt delivery schedule.

DELIVERY WITHIN 30 DAYS.

Pressure Range 15 to 20,000 P.S.I.
Dial Sizes 8½"—12"—16"
Prices from $166.75

Catalog on Request

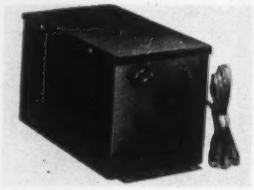
HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **94** on inquiry card.

NEW INSTRUMENTS

STABILIZING TRANSFORMERS

New voltage-stabilizing transformers provide output variations of less than ±½% for input fluctuations from 95 to 130 vac, with a rated output of 117 vac, 60 cps. Stabilizing



time lag is only a few cycles and they are unaffected by power factor or changes in load. 250- and 500-watt capacities are now available, while almost any combination of capacity, frequency and voltage can be supplied.—*Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.*

For more information circle **215** on inquiry card.

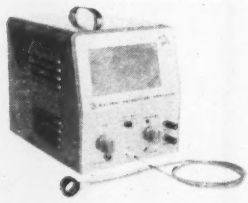
16" TURBO METER

New 16" 15,000-bph-capacity "Turbo-Meter" Positive Displacement Meter includes a rotor metering element weighing only 4 lb; a newly-developed viscosity compensator; and a magnetic coupling, completely sealed from the line product. Said to be a break-through in high-capacity metering, it has proved to be able to meter liquids of varying viscosities, at flow rates up to 15,000 bph, under continuous service conditions. Features include: capacity of 3,000 to 15,000 barrels per hour for viscosities up to 300 SSU, accuracy of 0.15%, and repeatability of 0.02%.—*Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.*

For more information circle **216** on inquiry card.

ABSORPTION ANALYZER

New Model PO-1 is designed specifically to add electrostatic pick-up and other analyzer features to conventional oscilloscopes. Traces signals

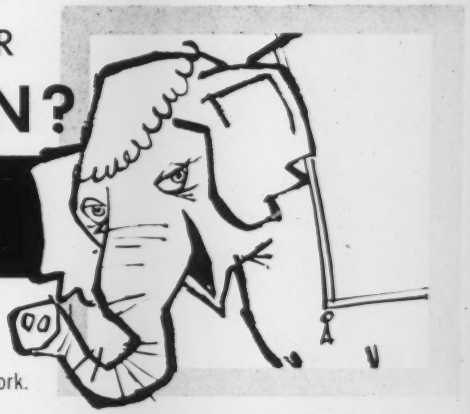


electrostatically in electronic circuits with periodic wave forms between 3mc and 240mc. A built-in speaker provides audible signal tracing.—*Kingston Electronic Corp., Medfield, Mass.*

For more information circle **217** on inquiry card.

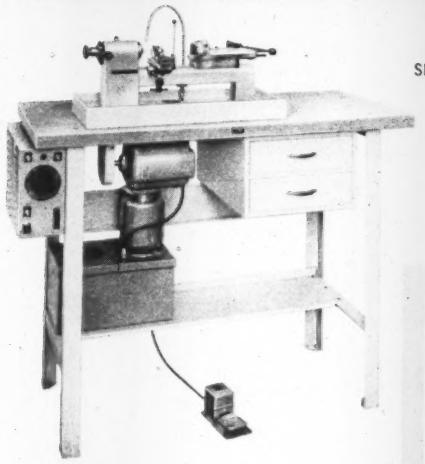
ARE YOU PROPERLY GEARED FOR

MINIATURIZATION?



LEVIN® TURRET LATHES

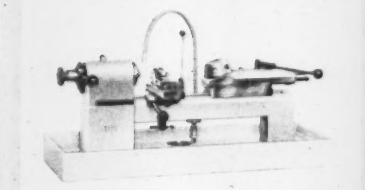
PRODUCE SMALL INSTRUMENT PARTS BETTER

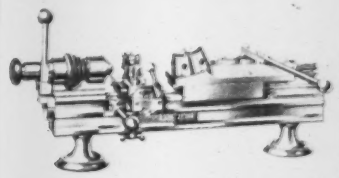


A complete Turret Lathe for small parts. Particularly useful for second operation work. Maximum collet capacity 5/16". Standard models provided with self indexing, six position turret, collet closer, double tool cross slide and variable speed control.

For full details of Turret Lathes and other Instrument Lathes send for catalog T.

Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.





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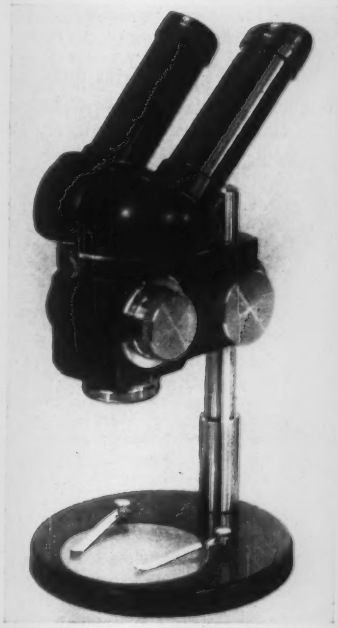
STEREO-MICROSCOPE

MADE IN WEST GERMANY

Uniform sharpness over the entire field of view. Erect, unreversed image. Outstanding plasticity; easy on the eyes, even during prolonged observation.

Novel rapid change of magnification from 6x to 160x with wide-angle oculars.

Large working distance from 3-¾ inches, with diameter of object field up to 32mm. Beyond 80x magnification, the working distance is 1-⅝ inch.



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GUARANTEED UNINTERRUPTED REPAIR SERVICE

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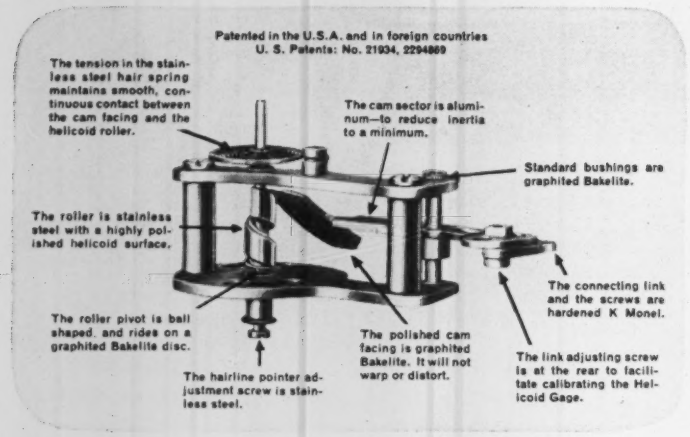

Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details **Ask for Catalog G-52**

HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.
929-B Connecticut Ave., Bridgeport 2, Conn.

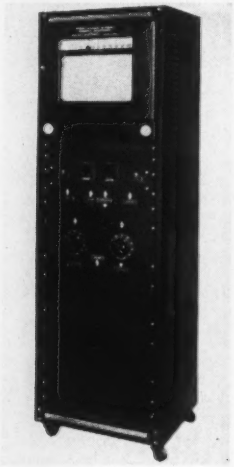
ACCO TRADE MARK

For more information circle **97** on inquiry card.

NEW INSTRUMENTS

PROCESS ANALYZER

New null-type Process Analyzer is based on the detection of refractive-index differences between a process stream and a desired sample. Unit includes a special repeater-type recorder

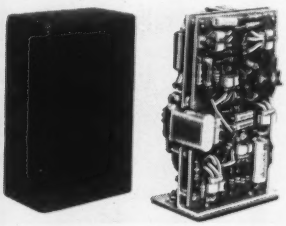


and can be supplied with electric or pneumatic proportional controller. Applications include: measuring and controlling of impurities in process stream; control of stream blending; concentration measurements; and identification of compounds from fractionators, stills or chromatographic columns.—*Phoenix Precision Instrument Co.*, 3803-05 *N. 5th St., Phila. 40, Pa.*

For more information circle **218** on inquiry card.

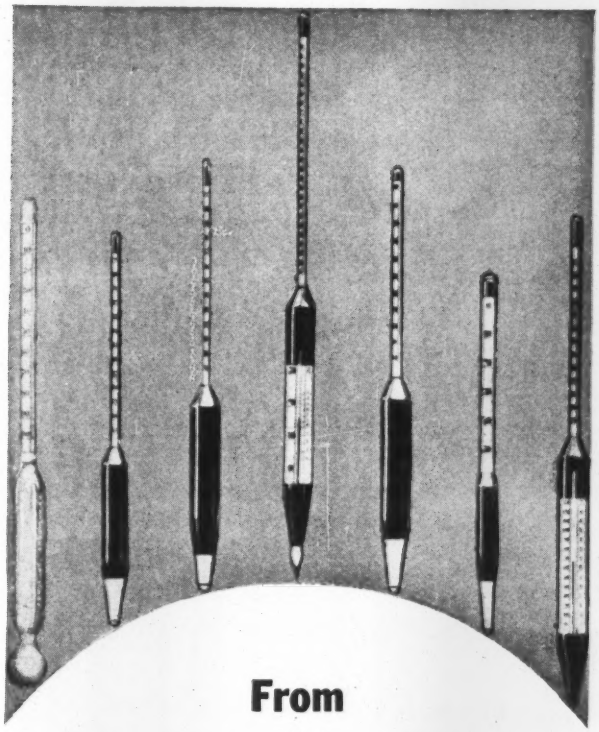
VOLTAGE COMPARATOR

New all-transistor 200-Series Voltage Comparator trips a DPDT-relay output when the unknown signal input exceeds the value of the known reference input. Device features sensitivity of 5 mvac, 10 mvdc; input impedance of 2 megohms (min.); low power requirement for 115V/400 cps



1 watt with relay operating (0.1 watt with relay non-operating); phase or polarity sensitivity; and no zero drift with d-c inputs. The output relay contact ratings are 2 amps at 28 vdc. Repeatability of trip point is ±1 mv. Meets MIL-E-5400A and MIL-E-5272. —*Trio Labs. Inc., Plainview, L. I., N. Y.*

For more information circle **219** on inquiry card.



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Glue to bonded Whiskey

if it's a liquid it has only one True density—Measure it with

MOELLER HYDROMETERS

Expert design and craftsmanship make Moeller Hydrometers the standard in measuring the density of any liquid. The streamlined tip construction, with special alloy ballast, provides a means of quick, accurate readings. All standard density scales. (Specific Gravity, Brix, Twaddle, Balling, etc.) Available in plain form also in combined form, which has built-in thermometer.

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Compact

LOCAL MOUNTED TEMPERATURE CONTROL

C7

TYPE **C7**

offers ▶ MINIMUM SIZE ▶ MINIMUM WEIGHT

The Type C7 control is a precision-built, enclosed, compact unit especially suited for internal-combustion engine cooling systems and other industrial applications with operating limits up to 425°F. Simplicity of design assures long-life and trouble-free service. This can be provided in a skeleton version (type C47) or calibrated (type B5).

Temperature Ranges	0° to 160°F, 0° to 250°F or 200° to 425°F.
Switch Ratings	15 amps at 115 or 230 volts A.C., also D.C. or 20 amp A.C. switches upon specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Mounting	½" NPT on immersion element is standard.
Size	Approximately $5^{13}/_{32}$" x $3^{5}/_{16}$" x $1^{9}/_{16}$".
Weight	Approximately 12 ounces.
Turning Radius	$2^{3}/_{8}$".

UNITED ELECTRIC manufactures a complete line of temperature, pressure and vacuum controls. For modifications or custom-built units consult a UE application engineer today. For more data on the type C7 control and other local mounted temperature controls request Section 100 of our *new* catalog.

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COMPANY
81 SCHOOL STREET, WATERTOWN, MASS

For more information circle **99** on inquiry card.

Varian STRIP CHART Recorders

Unique combination of performance, size and price

OVER 1000 TIMES AS SENSITIVE as galvanometer recorders . . . and Varian's null-balance potentiometer needs no power from the source being measured. Rugged, stable mechanism allows ink or inkless recording—easy-to-read rectilinear chart—source impedances of up to 100,000 ohms.

LESS THAN HALF AS WIDE as a standard 19-inch rack. Two Varian G-11A's mount side by side on a rack panel 10⅜ inches high. Or as a portable, the G-11A is an easy-to-handle 15 pounds. The G-10 sits on less than one square foot; its horizontal chart is handy for jotting notes.

MORE VERSATILE AND ADAPTABLE than any similar recorder — adjustable zero, adjustable span (from 9 to 100 mv on the G-11A), multiple chart speeds (up to four on the G-11A), and plug-in input chassis for different recording requirements.

PRICES THAT BEGIN AT $365 for the G-10 and $470 for the G-11A. Because unneeded performance costs money, Varian has intentionally designed for 1% limit of error and 1-second balancing time. Thus, Varian provides needed ruggedness, dependability and operating features at moderate cost.

FOR COMPLETE SPECS. AND STANDARD OPTIONS, WRITE INSTRUMENT DIVISION.

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For more information circle **100** on inquiry card.

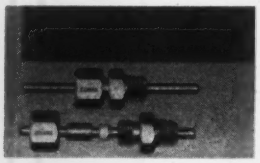
CALIBRATION STANDARD

New Model 1294, a digital-reading Instrument Calibration Standard, supplies a broad range of precisely controlled a-c and d-c voltages and currents, eliminating the ambiguity common to pointer readout of D'Arsonval-type standards of equivalent accuracy. Ranges: d-c voltages from 1 mv to 2000 v full scale in 12 scale ranges; d-c current (also in twelve ranges) from 10 microamps to 30 amps full scale. Accuracy on both is ±0.1%. A-c indication is true rms; voltages and currents (at an accuracy of ±0.3%, with 14 ranges for each function) are from 1 mv to 2000 v full scale, and 10 microamps to 30 amps full scale, respectively. Dynamometer type wattmeters can also be calibrated using d-c currents and voltages. Construction of the unit features a modern desk-type console.—*Radio Frequency Labs., Inc., Boonton, N. J.*

For more information circle **220** on inquiry card.

THERMOCOUPLE GLAND

New Micro Packing Gland is said to be one of the smallest available to the industry, measuring only 21/32" long and 11/32" hex. It can be used to seal tubes of any material (because of the soft Teflon sealant) such as ceramic, stainless steel, aluminum, brass, or even glass tubes. Temperature range is from −90°F to +500°F and seal pressures from 0.005 μ up to 1000 psi; with Lava sealant temperatures range from −300°F to +1850°F with pressures from 0.005 μ up to 3000 psi. Standard bore sizes are $\frac{1}{16}$" and $\frac{3}{32}$" and non-standard bore sizes range from 0.030" to 0.096". The $\frac{1}{16}$" IPS mounting thread is so small that it is uncommon in general usage; taps are available from stock.—*Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.*



For more information circle **221** on inquiry card.

Absolute ISOLATED DC POWER SOURCE

for

- RESISTANCE-TYPE TRANSDUCERS
- STRAIN GAGES
- ACCELEROMETERS

Now for the first time you can have the dependability and ease of operation of an electronic power supply *plus* the isolation normally obtained only from a battery. The Moeller Model 21 Power Supply exclusively provides *absolute isolation from line voltage and line ground.*

The Model 21 provides 0-20 volts, 1 amp of power for strain gages and resistance-type transducers. This transistorized instrument gives improved performance with existing single-ended and differential amplifiers and offers voltage regulation, internal impedance, ripple and stability equal to, or superior to, conventional transducer power supplies.

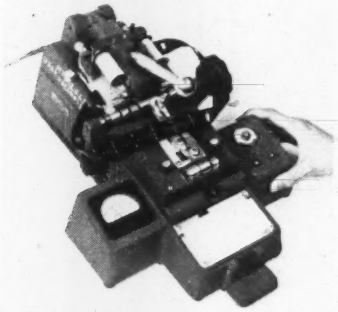
Write for descriptive literature.

MOELLER INSTRUMENT CO.
ELECTRONICS DIVISION
132nd Street & 89th Avenue
Richmond Hill 18, N. Y.

For more information circle **101** on inquiry card.

TAPE SPLICER

New "Presto-Splicer" Tape Splicer measures, cuts, and seals nylon-coated glass-fibre tape used in Bendix

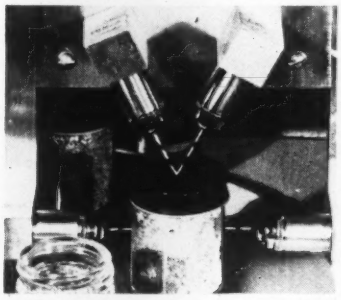


Eclipse-Pioneer's vertical-scale instruments, producing endless loops within precise length tolerance of ± 0.001". —*Prestoseal Mfg. Corp., Long Island City, N. Y.*

For more information circle **222** on inquiry card.

DUAL-BEAM ELECTRIC EYES

New dual-light-beam Electric Eyes use one beam to time inspection and another beam to monitor, eliminating

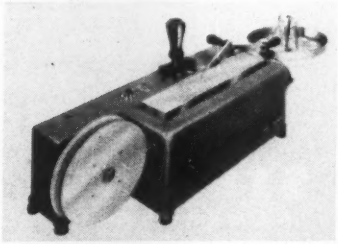


timers and mechanical contacts formerly used for monitoring of objects moving at varying speeds and positions.—*Photomation, Inc., Bergenfield, N. J.*

For more information circle **223** on inquiry card.

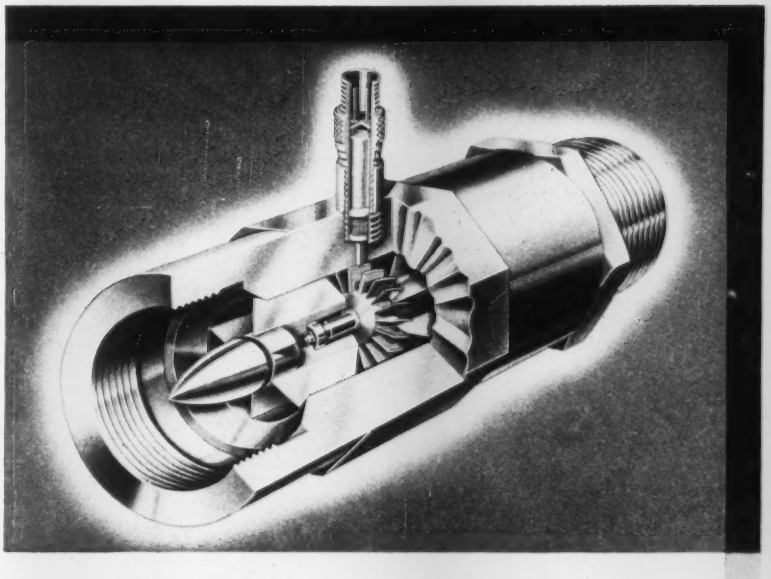
TAPE SPLICER

New coded punched Tape Splicer that edits, joins, or repairs mutilations of tapes of paper, parchment or



Mylar, without losing a single code, utilizes heat-sealing splicing tape impervious to environments. Also splices edge-punched cards.—*Editape Co., 32 Central Parkway, Huntington, L. I., N. Y.*

For more information circle **224** on inquiry card.



★ Meticulously calibrated to insure 1/2% accuracy
★ Easily disassembled for cleaning
★ High frequency output — 120 to 1200 cps
★ High transient frequency response
★ Unharmed by reverse flow

new COX turbine flowmeter

For over 46 years the name "Cox Instruments" has been synonymous with *precision* flow measurement. Such outstanding equipment as Cox Variable-Area Flowmeters and Cox Calibrating Stands have helped make it possible for industry to establish realistic standards for accuracy and reliability in flow measurement.

And now . . . the Cox *Turbine* Flowmeter joins this list of truly precision products. Developed to meet the exacting needs of modern instrumentation systems, it has received the acclaim of initial users throughout industry.

We welcome the opportunity to tell you more about the complete line of Cox Turbine Flowmeters. Write to *Cox Instruments Division, George L. Nankervis Company, 15200 Fullerton Avenue, Detroit 27, Michigan.*

COX

A new technical bulletin describes the complete line of cox turbine flowmeters. Ask for bulletin no. 1300a.

INSTRUMENTS

Precision Instruments Since 1912

GLN-1259

For more information circle **102** on inquiry card.

For SLIP-ON INSULATION
BUNDLE SHEATHING
BUSHING INSULATION
BARRIER INSULATORS, PIGTAILS

And Similar Applications Where Only PF TEFLON Can Do The Job*

ADVANTAGES . . .

- good dielectric strength (500 to 1000 volts/mil)
- lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric
- no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc).
- zero moisture absorption
- unaffected by any commercial chemical

PF spaghetti tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

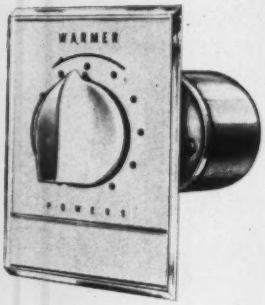
PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Philadelphia 4, Pa.
EVergreen 6-0603 TWX PH 252

*"Teflon"—DuPont trade name for Tetrafluoroethylene resin

For more information circle **103** on inquiry card.

POSITIONING SWITCH

New responsive ball valve in Pneumatic Positioning Switch eliminates lag (hysteresis) between a change in switch position and a corresponding change in the controlled motor or



valve. Switch is 20% smaller than earlier models permitting more compact surface or flush mounting.—2-page Sales Bulletin 357-3 and 6-page Instruction Form P-75 give details.—*The Powers Regulator Co., 3434 Oakton St., Skokie, Ill.*

For more information circle **225** on inquiry card.

ELECTRONIC TIMER

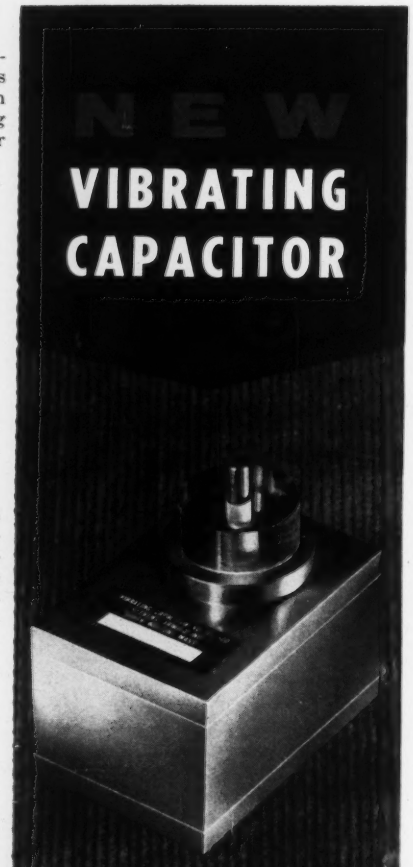
New Electronic Delay Timer (time delay relay), a completely self-contained unit in a steel can (2" x 2-¼" x 3⅛"), with octal radio type plug for mounting and wiring connections, em-

ploys a unique circuit to control the breakdown of gas tubes and to provide timing delays from 0.003 to 300 sec unaffected by variations in line voltage. It can be provided with a SPDT or a TPDT relay or can be furnished to operate a relay external to the timer.—4-page Bulletin 159 gives details.—*G. C. Wilson & Co., Huntington, W. Va.*

For more information circle **226** on inquiry card.

128-CHANNEL SCALER-ANALYZER

New RCLiac-128, a completely integrated system, features plug-in module construction; "instant" number or curve CRT display; magnetic-core-memory capacity of 1,000,000 counts per channel; pre-set time of 0.19 sec to 28 hours; pre-set count of



A vibrating-reed type capacitance modulator for use in measuring currents as low as 10^{-16} amperes.

Long term stability for process control. Drift ±0.2 millivolts per day, non-cumulative.

Write for Catalog 523.

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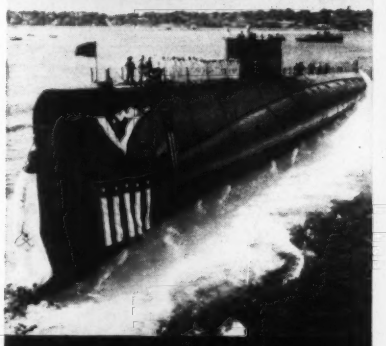
For more information circle **104** on inquiry card.

WEKSLER INSTRUMENTS



on Five out of Five

For the finest, nothing but the finest design, engineering, construction and equipment.

What's aboard the TRITON, the nation's fifth nuclear powered submarine in the way of instruments to indicate and record temperature, pressure and humidity?

Weksler...just as it's Weksler on the Nautilus, Seawolf, Skate and Skipjack. We're proud of the distinction and of our contribution to the nation's defense, and just as proud of our instruments for earning for us this honor.

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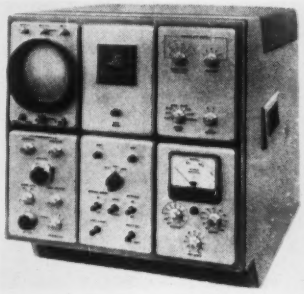
WEKSLER INSTRUMENTS

WEKSLER INSTRUMENTS CORP.
FREEPORT, L. I., NEW YORK
INDICATING AND RECORDING INSTRUMENTS FOR TEMPERATURE PRESSURE AND HUMIDITY

For more information circle **105** on inquiry card.

2^1 to 2^{24}; 600-to-1500-v negative high voltage, stable to 50 ppm with well regulated line; overall amplifier gain of 1,000; and integral linearity of ADC less than $\pm 1\%$ for channels 5

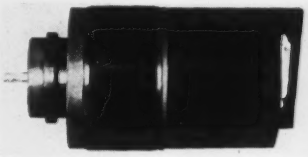


through 128. Instrument adds and subtracts through logical decimal arithmetic circuits and performs nuclear-data-processing operations from gross counting through scintillation spectroscopy.—*Radiation Counter Labs., Inc.*, 5121 *W. Grove, Skokie, Ill.*

For more information circle **227** on inquiry card.

SHAFT POSITION ENCODER

New Type RD-13B Digisyn, a 13-digit photoelectric Shaft Position Encoder has increased ruggedness and resistance to vibration and shock over older types. It provides outputs of 10

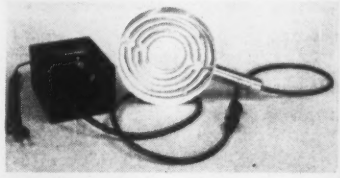


v $\pm$ 10% over a temperature range of from $-40°$F to $+165°$F, and a signal to null or "one" to "zero" ratio in excess of 100:1 over this range.—*Wayne-George Corp., Adcon Div.*, 1117 *Commonwealth Ave., Boston* 15, *Mass.*

For more information circle **228** on inquiry card.

COLD LIGHT SOURCE

New Aristo Mic-O-Lite II featuring four rings of cold shadowless light in a doughnut-type reflector, 6"



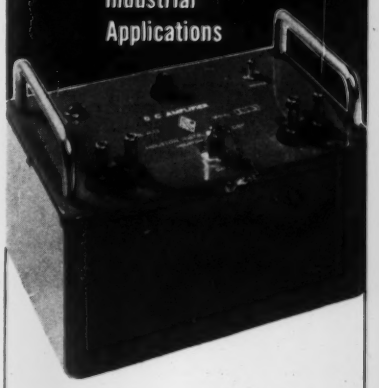
in dia, which provides a 2¼-inch aperture in its center, is an ideal source for precision inspection under magnification.—*Aristo Grid Lamp Products Inc., 65 Harbor Rd., Port Washington No., L. I., N. Y.*

For more information circle **229** on inquiry card.

MODEL M-10

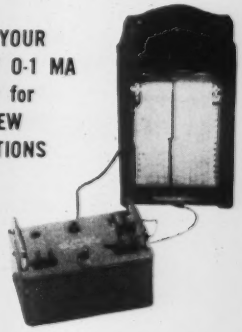
DC AMPLIFIER

Drift-Free Chopper-Stabilized Multipurpose DC Amplifier for Laboratory and Industrial Applications



Versatile, reliable, the M-10 is suitable for many applications where low level DC amplification is required. May operate from either current or voltage source and provide either current or voltage output with proper shunts.

UTILIZE YOUR PRESENT 0-1 MA Recorder for MANY NEW APPLICATIONS



The M-10 is ideal for use with 0-1 MA recorders. High output impedence prevents excessive damping. A trim adjustment is provided to calibrate the combination to ½%. Linearity is better than ½% for the amplifier. (Combination usage shown is with Esterline-Angus 0-1 MA Recorder)

WRITE FOR BULLETIN

houston instrument
corporation

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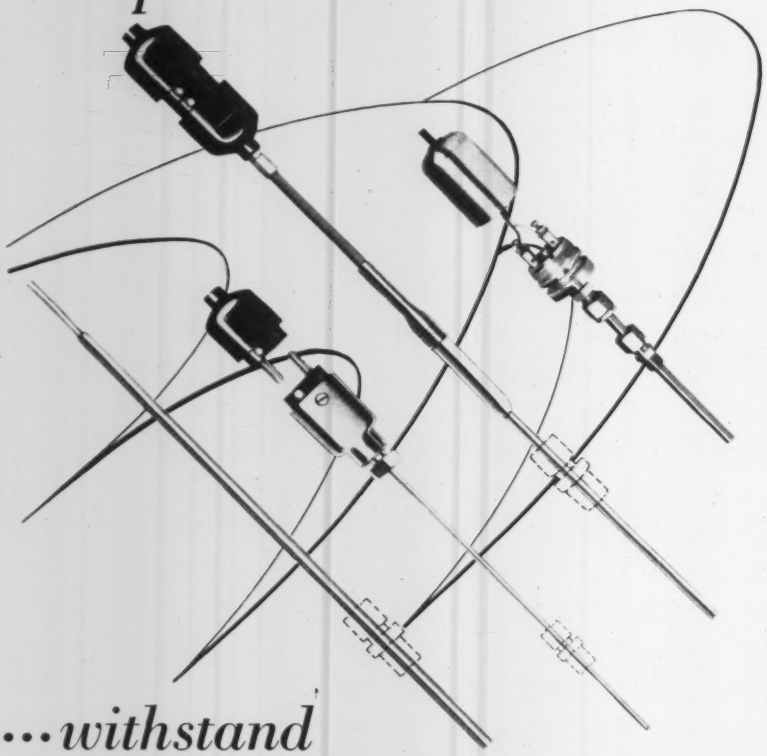
CA 5-6964

For more information circle **106** on inquiry card.

SUPER-TEMP THERMOCOUPLES

respond with SPEED · · ·



· · · withstand

HIGH PRESSURE · HIGH TEMPERATURE · THERMAL SHOCK

The above units are available in sheath diameters from .020–.250 • they can be supplied in the following sheath materials: type 304, 310, 316, 347 stainless steel, Inconel*, platinum, tantulam, copper and aluminum • a special select grade of wire is used at all times to insure accuracy • the sheath will withstand thousands of pounds external pressure • the hard pack high temperature insulation allows the sheath to bend or form without damage to the "hot junction" or without grounding thermocouple wires to the sheath • the "hot junction" end is welded with the same material as the sheath

* Trademark Registered, International Nickel Company

Write for our simplified brochure that will assist you in specifying the proper thermocouple for your application.

Your local representative will be pleased to assist you with all special applications.

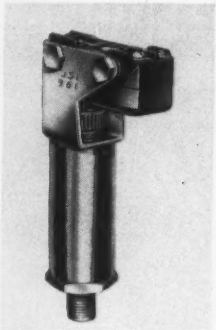
THERMO-COUPLE PRODUCTS COMPANY, INC.

729 North Addison Ave., Villa Park, Illinois

For more information circle **107** on inquiry card.

PRESSURE CONTROLLERS

New Models 670 and 680 in the line of J51 pressure controllers increase the adjustable range from 350

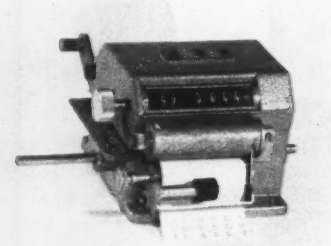


to 1700 psi. Model 670 ranges from 50 to 1000 psi, and Model 680 from 100 to 1700 psi. Both models have a maximum bellows pressure of 3500 psi.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **230** on inquiry card.

PRINTING COUNTER

New Model U 271S Printing Counter driven by servo or synchro motors from shaft input has counting rate of 5,000/min max, either adding or sub-

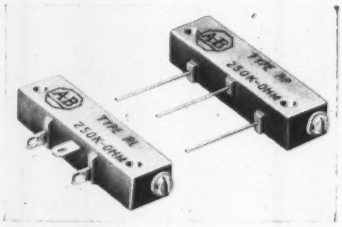


tracting. Maximum complement of digits is 7 (non-resettable) or 6, if reset is required. Printing can be on tape or card. —*Presin Co., 2014 Broadway, Santa Monica, Calif.*

For more information circle **231** on inquiry card.

ADJUSTABLE FIXED RESISTOR

New Type R Trimmer Potentiometers having a solid hot-molded resistance element and a molded carbon brush, a self-locking moving element and an adjustable 25-turn range, provide high stability for critical elec-

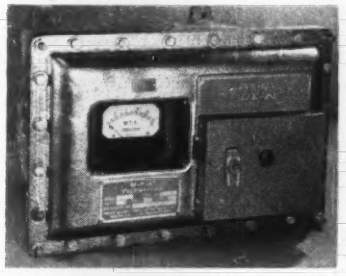


tronic circuitry. Rated ¼ watt at 70°C ambient temperature and a maximum of 350 v, they are available with resistance values from 100 ohms to 2 megohms ±10% and ±20%.—*Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.*

For more information circle **232** on inquiry card.

GAS CONCENTRATION METER

New Thermatron measures concentration of one gas in a multi-component mixture selectively and continuously by thermal-conductivity principle of measurement with additional convection cells which take into



account differences in convective heat losses from hit filaments through gases. Calibration is for any gas over either narrow (0-1%) or wide (0-100%) ranges of gas concentration. Accuracy is within 2% of full scale.—*Mine Safety Appliances Co., 201 N. Braddock St., Pittsburgh 8, Pa.*

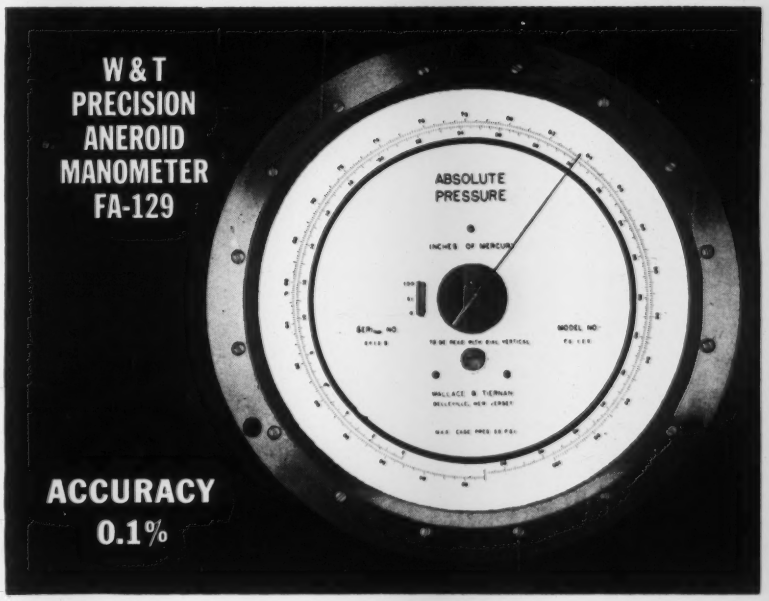
For more information circle **233** on inquiry card.

HIGH-VACUUM EVAPORATOR

New modular High Vacuum Evaporator VE-400, one of a new series of modular 4" systems, features stainless-steel construction, fast pump-down, and low ultimate pressure. These systems permit the purchase of a high-vacuum system, or evaporator, and allow additional equipment to be

incorporated as it is required. Optional equipment includes base plates with or without bell jar and guard, 400-amp feed-throughs, octal header, glow discharge post, evaporator control assembly, heater posts, and a push-pull rotary seal for imparting motion to objects inside the bell jar.—*Veeco Vacuum Corp., 86 Denton Ave., New Hyde Park, L. I., N. Y.*

For more information circle **234** on inquiry card.



PRECISE CALIBRATING STANDARD
...For Absolute Pressure Work

Ranges: 0 to 31.5 inches of Hg. absolute (min.)
0 to 100 inches of Hg. absolute (max.)
Other intermediate ranges available

Accuracy: 1/1000 of full scale

Sensitivity: 1/10,000 in *all* ranges

Scale Length: 45 inches in two revolutions

Dial Size: 8½ inch diameter

Write for Publication No. A-112.48

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is your feeding problem peculiar to your operation?

Wallace and Tiernan's volumetric feeders are so flexible that each job is practically custom built. W&T's experience is broad enough to meet any challenge.

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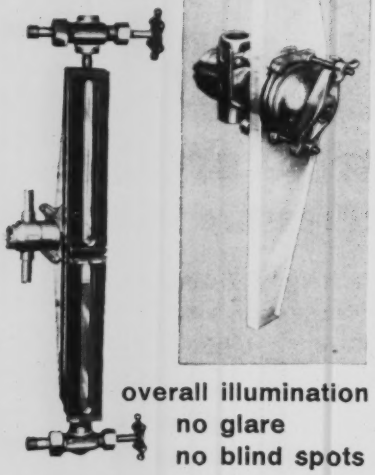
For more information on Manometer circle **108** on inquiry card.
For more information on feeders circle **109** on inquiry card.

NEW!
PENBERTHY ILLUMINATORS
for Liquid Level Gages

58 WATT 3000 HOUR BULB

accurate readings



overall illumination
no glare
no blind spots

Faster, more accurate liquid level readings are provided by Penberthy's new, improved, explosion-proof, dust-tight illuminators. 58 Watt Bulb (with medium screw base) gives higher light intensity for 4-times the life of ordinary illuminators. Exclusive rugged aluminum housing over bulb extends bulb life, offers better protection and simplifies relamping. Clear plastic wedge diffuses light over entire length of gage glass.

Illuminators are easily installed on present or new gages. Available in single or double sections, they are used in combination for gages with 3 or more sections. Approved by Underwriters' Laboratories for Class 1, Group C and D hazardous locations.

For further information on Penberthy Illuminators, liquid level gages and valves, write or phone. Ask for Caralog #36.

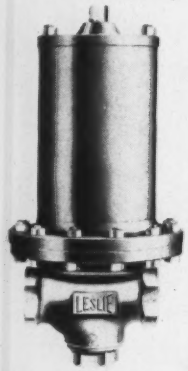
PENBERTHY

PENBERTHY MANUFACTURING CO.
Division of Buffalo-Eclipse Corporation
1242 Holden Ave., Detroit 2, Michigan

For more information circle **110** on inquiry card.

PRESSURE REGULATOR

New Leslie-Topper Steam Pressure Reducing Valve employs a mechanical pilot device which is entirely out of the path of steam and therefore elimi-

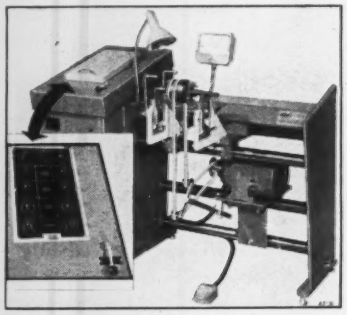


nates troublesome dirt catching and close fitting parts. Tests, it is claimed, show a flat capacity-regulation characteristic, indicating close control throughout the operating ranges.—*Leslie Co., 122 Delafield Ave., Lyndhurst, N. J.*

For more information circle **235** on inquiry card.

PRODUCTION BALANCERS

New Bear Bekomatic Balancers for production line balancing of rotating parts are offered in three horizontal



models: No. 4B, No. 40B (illustrated) and No. 400B (each figure representing maximum weight capacities); also two vertical models having weight capacities of 20 lb and 75 lb. Features are single knob control and simultaneous indication of amount and location of unbalance.—*Bear Mfg. Co., Rock Island, Ill.*

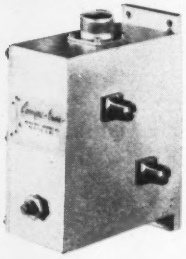
For more information circle **236** on inquiry card.

GAS CHROMATOGRAPH

New Chromacon, Series 9580, which can be operated with one or two columns in the compartment from room temperature to 300°C, has three interchangeable detectors with an argon ionization gage. Usually supplied with filament- or thermistor-type thermal-conductivity detector, the more sensitive ionization detector can be purchased separately. A proportional-control circuit insures close regulation and uniformity of column and detec-

NEW
IRC

ZERO-SETTING PRESSURE TRANSMITTER



Measures Differential and Absolute Pressures

●

High Reliability—High Accuracy

●

Excellent for industrial process applications, and military testing

You now have at your disposal an instrument adaptable to a larger number of both industrial and military applications—the new IRC Compu-tran Zero-Setting Pressure Transmitter.

May be zero-set for any environmental situation or to obtain zero output for any pre-set differential between high and low pressure inputs.

The use of two opposing Bourdon tubes with a single magnetic pick-off mounted between makes it possible for the measured fluids to be contained within the tubes and not in the housing. The sealed case provides complete corrosion and explosion protection.

Ranges: 0-100 thru 0-5000 psi static pressure. Differentials up to 100% of range.
High Accuracy: ±0.25%, infinite resolution, output voltage proportional to pressure.
High Reliability: Frictionless magnetic pick-off, guaranteed life 10,000,000 cycles (min.).
High Sensitivity: Sensitive to 1 part in 1000.
Input: 110V or 6.3V AC 60 cycle standard, adaptable to other voltages, frequencies.
Output: 10 to 100 MV to 5 volts. AC or DC. DC output can be fed into instruments calibrated in ranges of 10, 50 or 100 millivolts.
Temperature Compensated: Output stable over full range of ambient temperatures.

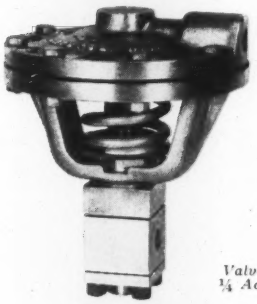
Write for full information—Bulletin R-11

Compu-tran

International Resistance Company
COMPUTER COMPONENTS DIVISION
Dept. 452, 401 N. Broad St., Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd. Toronto, Licensee

For more information circle **111** on inquiry card.

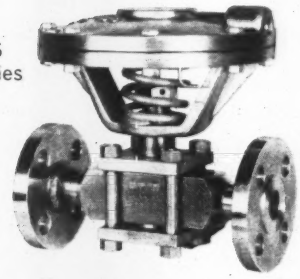
MINIATURE VALVES



501 Series

Valves shown ¼ Actual Size

526 Series



RUGGED

"BANTAM"

THROTTLING CONTROL VALVES

Compact throttling controls of the 501 series have one-piece barstock bodies with screwed ends and are available with linear, equal percentage or quick-opening plug characteristics. This series offers six operators, direct and reverse acting, including two with positioners.

The 526 series includes 6 body styles in globe, angle and 3-way design — with screwed or flanged ends. Four bonnet types cover standard, high or low temperature and packless applications. Six control operators are offered with up to 50 square-inch diaphragms.

	501	526
Pressure Rating	1000 psi (at 450°F)	1000 psi (at 450°F)
Temperature Rating	−70°F to +450°F	−70°F to +450°F (750°F with finned bonnet)
Maximum Cv.	0.63	10.0 (1" connections)
Lift	¼"	7/16"
Seat Area	0.038 sq. in.	up to 0.601 sq. in.
Connections	⅛", ¼", ½" N.P.T. Standard (others available)	¼" to 1" N.P.T. ½" to 1" flanged

Send for the BANTAM Catalog No. B-1 and other technical data on Dahl pneumatic and hydraulic valves.

George W. Dahl Company, Inc.
86 Tupelo Street
Bristol, Rhode Island

For more information circle **112** on inquiry card.

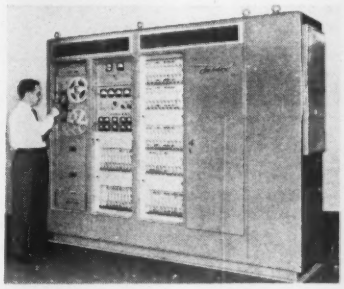
tor temperature. A recorder records (1) operating current to thermal-conductivity bridge, (2) column temperature, and (3) temperature of the liquid sample introduction point. A

non-lubricated gas sample valve gives a high degree of reproducibility of analytical results.—2-page leaflet contains details.—*Podbielniak Inc., 341 East Ohio St., Chicago 11, Ill.*

For more information circle **237** on inquiry card.

MACHINE CONTROL UNIT

New Bendix Machine Control Unit permits simultaneous control of 4 independent motions of milling machine from punched-tape input. A high-



speed tape reader allows tape reading of 300 lines/sec in the forward direction and 600 lines/sec in the reverse direction. Command resolution is 0.0002" linear and 0.01° rotary.—*Bendix Aviation Corp., Industrial Controls Section, 21820 Wyoming Ave., Detroit 37, Mich.*

For more information circle **238** on inquiry card.

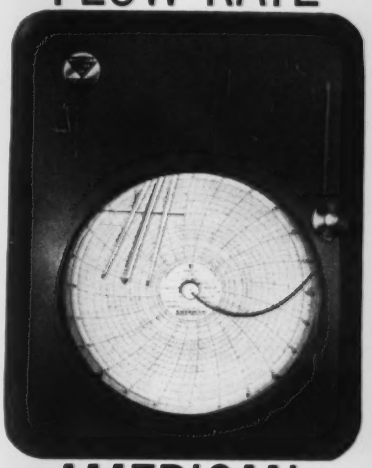
QUICK BNC CONNECTORS

New line of BNC Quick-Crimp RF Connectors is partially pre-assembled before shipment into only three basic

parts for quick assembly. They mate with standard BNCs if desired. Rating is 500 v peak. VSWR is low up to 10 Kmc.—*Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.*

For more information circle **239** on inquiry card.

PRECISION MEASUREMENT AT ANY FLOW RATE



AMERICAN-WESTCOTT A-88

ORIFICE METERS

Versatile American® Series A-88 mercury-type orifice meters meet the toughest flow measurement requirements – working pressures to 5,000 psi – interchangeable 10, 20, 50, 100 and 200-inch ranges. Recording meters may be equipped with 0-150° F. standard temperature element. Integrating meters integrate static and differential pressure, providing totalized flow indications. Telemetering equipped meters transmit integrated indications to remote locations.

- Manometer body easily cleaned – does not affect calibration.
- Tamper-proof calibration — simple, positive adjustment of float lever arm length.
- Interchangeable ranges — no manifold piping changes.
- Teflon-packed stuffing box is pressure tight, nearly frictionless, never needs lubrication.
- Teflon-packed pulsation dampener externally adjustable under full line pressure.
- Check valves give positive shut-off for over-range protection.

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1874)
General Offices: Philadelphia 16, Pa.
Sales offices in principal cities

For more information circle **113** on inquiry card.

NEW CARL ZEISS JENA
OPTICAL DIVIDING HEAD

PERMITS PRESETTING TO ANY DESIRED MINUTE AND SECOND FACTOR FOR NEXT OPERATION WHILE FIRST OPERATION IS IN PROGRESS

does not depend for accuracy on worm, worm gears or index plates. It is a thoroughly practical, rigidly constructed tool.

AT LAST available again the ORIGINAL CARL ZEISS JENA

INDEXING BY A DIVIDED GLASS CIRCLE AND VERNIER, FULLY PROTECTED AND ENCASED, MOUNTED DIRECTLY ON SPINDLE, THUS NO INACCURACY FROM GEARING, WEAR OR PLAY.

BUILT FOR PRODUCTION USE on MILLER and GRINDER

Accuracy ±5 Seconds
Range of Scale: 0 to 360 Degrees

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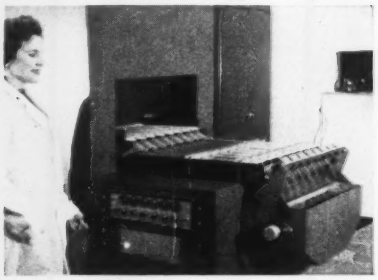
COMPLETE LINE OF PRECISION INSTRUMENTS
WEST COAST BRANCH: SCHERR-TUMICO CO. - 3337 W. Olympic Blvd. - Los Angeles 19, Cal.
200 MG LAFAYETTE STREET • NEW YORK 12, N. Y.

For more information circle **114** on inquiry card.

dekatron®
FOR FAST AND ACCURATE COUNTING

cold-cathode glow transfer counting TUBES up to 20,000 counts/sec



DELTA ENGINEERING CORP., When developing this high-speed Automatic Counting Machine, evaluated many preset counters, Delta decided on an electronic count control using Baird-Atomic Dekatron counting tubes. The machine can tally up to 5-million manufactured parts an hour with an accuracy of 1/10 of 1% — an application requiring the extreme reliability and performance gained by Dekatron's more than 10 years of service.

For full details on Dekatron glow-transfer tubes and patented drive circuits, write to . . . .

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS
Baird Atomic

Instrumentation for Better Analysis

For more information circle **116** on inquiry card.

16 POSITION enclosed switch

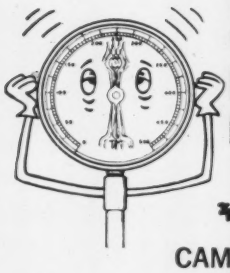
ESCO rotary multipole SWITCH

- 16 contact positions per pole.
- Up to ten poles, or sections.
- Panel mounting.
- Electrical ratings—5 amperes 125 volts a-c interrupting.
- 22½° positive detent action.
- Contact resistance 0.001 to 0.005 ohms (all-silver contacts).
- Can be assembled to meet Military specifications.

The ESCO Type HT rotary multipole switch provides greater versatility in an enclosed-type switch. The switching action is fully enclosed in the molded phenolic structure of each section. A single knob controls the entire assembly permitting centralized control of complex circuits. *Write today for Bulletin 6.*

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
Weymouth 88, Massachusetts

For more information circle **115** on inquiry card.

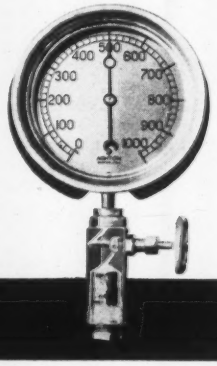


SURE CURE for HEADACHES DUE TO PRESSURE GAUGE JITTERS

CAMPBELL MICRO-BEAN

UNIVERSAL PULSATION DAMPENER

A Campbell Micro-Bean cures a headache ten times as fast as aspirin provided the headache is caused by a pressure gauge with a bad case of the jitters. Rapidly becoming the standard pulsation dampener in many industries all over the world.



Write for Literature -

J. A. CAMPBELL COMPANY
645 East Wardlow Road
Long Beach 7, California

For more infromation circle **117** on inquiry card.

INSTRUMENTATION NEEDED ICS-4A

In many applications, the measurement and control of variables depends on *barely adequate* techniques and equipment—while in others, no satisfactory solutions seem available.

1. What variables *can't* you measure satisfactorily?

   Variable? _____

   In what application? _____

   Units and range of measurement required: _____

   Needed in plant ☐; in laboratory ☐; in continuous operation ☐.

2. Present Status: a. No instrument available ☐.

   b. Instrument is available using _____

   _____ principle of operation, but unsatisfactory due to:

   ☐ Poor reliability ☐ Low accuracy
   ☐ High first cost ☐ Slow response
   ☐ High maintenance Other reasons: _____

3. Special environmental or application conditions the instrument might encounter:

   _____

4. Acceptable price for such an instrument estimated at $ _____

   (range), because benefits of such an instrument could be in $ _____

   (range) annually. Other benefits might be _____

   _____.

5. Your title _____ Company's Product _____
   (No signature necessary)

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B. Do you find its advertising useful in your work? ☐ Yes ☐ No

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Thanks again for your cooperation.

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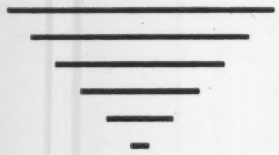
As a reader of *Instruments and Control Systems*, your answers to the questions on the card below can help guide our editorial efforts in those measurement and control areas of most interest to you.

We appreciate that answering the questions below will take several minutes; but you and other readers are the only persons who can provide the information we need.

Also, your answers will help focus attention on the control problems ***which you pinpoint and where you feel most concentrated effort should be applied.***

HELP US TO HELP YOU

find solutions to your more perplexing control problems ...



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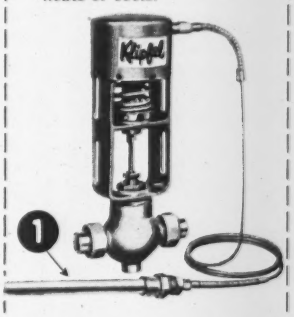
845 RIDGE AVE., PITTSBURGH 12, PA.
For Booth List circle **119** on inquiry card.

"Here's how modern self-operating temperature regulators work"

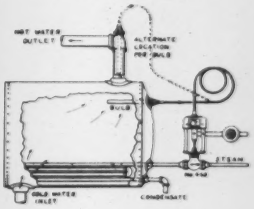
For complete information, send for a free copy of Klipfel Bulletin 354

"*Bulb (1) is placed* in tank or line where temperature needs controlling. Valve is installed in steam, water, gas or other line which heats or cools."

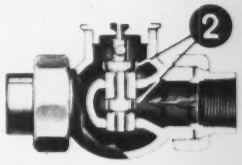


"*As temperature* changes at bulb, fluid vapor pressure in bulb changes, too. Capillary tube transmits pressure to bellows, which instantly and smoothly changes valve opening and maintains desired temperature in system."

TYPICAL INSTALLATION



"*Spring-loaded Klipfel* Regulator here has double-seated (2), semi-balanced inner valve. Not for tight-closing applications. Klipfel single-seated Regulators, however, are. Both types prevent overheating, product spoilage, equipment damage."



Klipfel Temperature Regulators are completely self-actuated, either spring loaded or weight and lever, single or double-seated. They need no compressed air, electricity, water, etc. Direct acting types close as temperature rises, reverse acting open; 3-way types, used for mixing, close hot water inlet and open cold water inlet when temperature rises.

*Bulletin 354 describes temperature regulators and has many pages of information you'll want to keep. Write on your letterhead for a free copy.

HAMILTON • OHIO **Klipfel** VALVES, INC.

Automatic Temperature-and-Pressure-Regulating Valves Since 1902

Float Valves • Temperature Regulators • Back Pressure Valves • Reducing Valves

A DIVISION OF THE HAMILTON-THOMAS CORPORATION

For more information circle **118** on inquiry card.

TOPS 'EM ALL

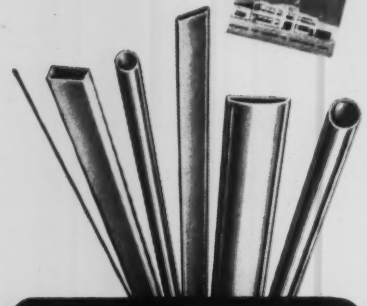
IN QUALITY OF TUBING

Comparative quality tests by one of America's leading users of tubing proved only Precision Tubing rates excellent in all specifications . . . yet Precision Tubing costs no more.

Precision Tubing is unequalled and unsurpassed in quality tests of accuracy, temper, straightness and roundness. You are sure of extra quality in every size tube at regular mill prices. Available in sizes from .010" to 1.125" O.D. in copper, brass, aluminum, up to ⅝" O.D. in nickel and nickel alloys, Ni-Span "C", phosphor bronze and nickel silver. In straight random lengths, coils or preformed shapes to specifications.

Write for catalog and technical data to Dept. 9, Precision Tube Company, Inc., North Wales, Pa.

GET THIS NEW TUBING DATA CATALOG



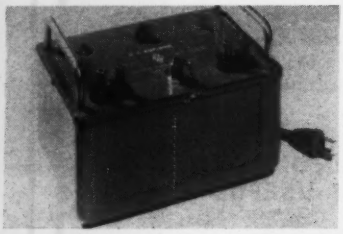
PRECISION TUBE COMPANY

For more information circle **120** on inquiry card.

NEW INSTRUMENTS

D-C AMPLIFIER

New M-10 multipurpose chopper-stabilized d-c Amplifier has a current output proportional to a millivolt input. In connection with 0-1-ma meter-

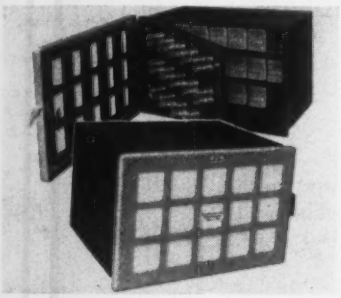


movement recorders it can be used to record inputs of 0-10 mv at an input impedance level of 10 megohms, registering the outputs of strain gages, remote thermocouples, or other transducers in the frequency range of 0-2 cps. Used with a 0-1-ma or 0-100 microammeter it becomes a 0-10-mv or 0-1-mv d-c VT millivoltmeter. With suitable shunts it can be used as a current or voltage amplifier. Accuracy is 1%, linearity is ½%, and drift is less than 50 μv referred to the input. 2-page bulletin gives details.—*Houston Instrument Corp., 1717 Clay Ave., Houston 3, Texas.*

For more information circle **240** on inquiry card.

ANNUNCIATORS

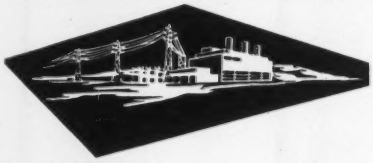
New U-200 Universalarm Annunciators operate on either normally-open or normally-closed err-contacts. Twelve types of visual and audible

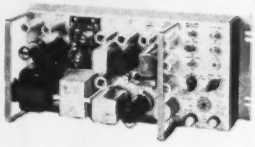


annunciation sequences can be obtained at any station, such as automatic reset, lock-in, or ring-back. Sequence patterns can be altered without changing the universal relays. Completely serviceable from the front, the U-200 is made as either an a-c or d-c system, with automatic warning in the event of power failure. An auxiliary NO or NC contact is available at each supervision station for use in external control, interlocking, or for remote annunciation. Equipped with mechanically-interlocked plug-in relays, timers, and flashers, it is made in 105 standard sizes with 6 to 36 indicator windows.—8-page Bulletin ANN/5/91 contains details.—*Electro-Mech Corp., 55 Oak St., Norwood, N. J.*

For more information circle **241** on inquiry card.

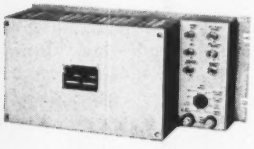
Telemeter ANY VARIABLE from Remote Points





MODEL 1025 Transmitter

MODEL 1090 Receiver



Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

Built-in Self-Calibrating Circuit

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU

Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

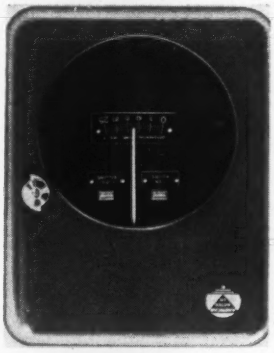
Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **121** on inquiry card.

BTU METERS

New low-priced mechanical BTU Meter, Model 200-MR, accounts for refrigeration or heating furnished by central air conditioning systems using chilled or hot water, by multiplying temperature change of the water lines



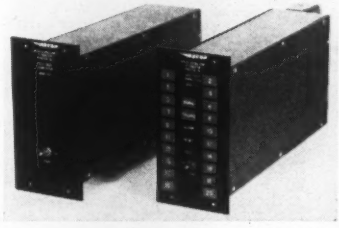
by flow measured by a water meter, connected by a flexible shaft. Two counters register the heat transferred and the water flow. Indication of differential temperature is provided. Any water volume above 0.25 gpm can be metered.—Product Data Sheet 200-MR-1 gives details.—

★ Model 200-MO, for process applications, includes a Type A-70 orifice meter with flow integrator.—Product Data Sheet 200-MO-1 gives details.—*American Meter Co., Mechanical Components Dept.* 4400 *Forest Lane, P. O. Box* 306, *Garland, Texas.*

For more information circle **242** on inquiry card.

FAULT-FINDER ALARM

New Fault-Finder Alarm System, requiring only one communications channel ranging from a pair of wires to a sub-carrier radio or microwave channel, features a transistorized ring-counter scanner that monitors (in a basic system) up to 20 separate



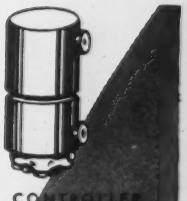
items at a scanning rate of 10 points/sec. Special designs are available for monitoring a larger number of items. Each monitored item is represented by a switch. If the switch is open, normal and safe operating conditioning is indicated. If a switch is closed, a unique pulse is generated by the scanner-transmitter unit, and a flashing lamp, plus audible alarms, announce the off-normal condition at the receiving-annunciator unit.—*Applied Science Corp. of Princeton, (ASCOP), P. O. Box* 44, *Princeton, N. J.*

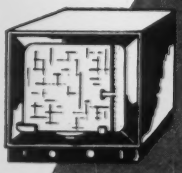
For more information circle **243** on inquiry card.

check your process instruments on stream with

NEW W & T

portable, precision pneumatic calibrator





A-755 with cover removed
26 pounds
8½" x 13¾" x 19½"

sensitive to pressure changes as small as 0.01% of full scale

Accuracy: 0.1% of full range

Standard range: — 1 to 24 p.s.i. other ranges available

For complete information, write to Dept. A-124.48

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IN CANADA: WALLACE & TIERNAN LTD., WARDEN AVE., TORONTO 13, ONT.

IF IT'S FREE FLOWING AND DRY

we have accurate reliable means of feeding it. For information about these dry chemical feeders *both gravimetric and volumetric...*

Write Dept. M-42.48

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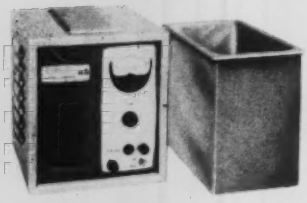
For more information on Calibrators circle **122** on inquiry card.

For more information on Feeders circle **123** on inquiry card.

ultrasonics Cleans parts in seconds

CIRCOSONIC® Multi-Purpose cleaning units pay for themselves in quick order by radically cutting costs and saving labor. They are ideal for removing excess solder flux, fingerprints, lint, waxes, polishing compounds from such parts as gears, bearings, instruments and hundreds of other applications.

CIRCOSONIC units are available in a wide range of sizes to serve your every cleaning need. CIRCO engineers will be pleased to offer technical assistance and recommend the specific units to fit your needs.



with CIRCOSONIC® cleaners

Send for our new booklet "Tips on Ultrasonic Cleaning."

CIRCO ultrasonic CORPORATION

Specialists in ultrasonic energy
51 TERMINAL AVENUE, CLARK, NEW JERSEY

For more information circle **124** on inquiry card.

ACCURACY

in modern scientific instruments often depends on controlling the direction of light without:

DISTORTION • DIFFRACTION

DIFFUSION

Consult the pioneers in evaporated metal coatings for:

- first surface mirrors with half-wave protection
- semi-transparent mirrors metallic and non-metallic
- beam splitters
- optical filters

Send for our free booklet. We have experience and skill to put at your service in solving your individual light problem.

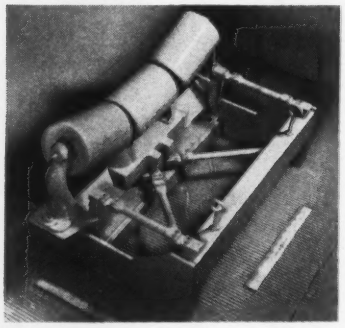
EVAPORATED METAL FILMS CORP.
Ithaca, New York
Dept. M.

For more information circle **125** on inquiry card.

NEW INSTRUMENTS

ELECTRONIC CONVEYOR SCALE

New Belt Conveyor Scale, utilizing an electrical transducer to convert instantaneous load weight into proportional voltages for continuous integration and digital display, is adaptable to existing plant equipment. Scale is efficiently used in simple weighing processes, proportioning, feeding and physical sampling systems.—*Bell Automation Corp.*, 125 *College Ave., Rochester 7, N. Y.*



For more information circle **244** on inquiry card.

OPTICAL PYROMETER

New Auto-Optic Recording Pyrometer measures extremely high temperatures with millisecond response time within ± 20°C, and surface changes in temperature over an area of ⅜" dia in the range of 1400°C to 3000°C. Monochromatic light of wavelength 0.65 μ is focused upon an opaque plate, having a small opening, which admits the radiant energy to a phototube.—*Avco Res. and Advanced Dev. Div., 201 Lowell St., Wilmington, Mass.*

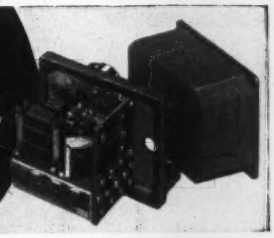
For more information circle **245** on inquiry card.

READOUT FORM PRINTER

New solenoid-operated Readout Form Printer, Model 1941, features a 12-decade capacity and an automatic form ejector. Printing data sources include digital voltmeters, shaft-position transducers of both the decimal and coded types, EPUT meters, electronic counters, step-switch banks and relay banks.—*Clary Corp., 408 Junipero St., San Gabriel, Calif.*

For more information circle **246** on inquiry card.

Tubeless Photoelectric Controls



Type BM1—magnetic amplifier. .04 second minimum dark time; .04 second minimum light time. DPDT contacts, rated 10 amps. at 115 VAC, non-inductive load.

Type BC1
Cad cell. .07 second minimum light time; .07 minimum dark time. SPDT contacts rated 4 amps. at 115 VAC, non-inductive load.

Type BT1
Transitor. .04 second minimum dark time; .04 second minimum light time. SPDT contacts rated 8 amps. at 115 VAC, non-inductive load.

Designed for heavy duty industrial service. Available with self-contained or remote heads and a great variety of light sources to meet the widest range of application needs.

Complete catalog and supplement includes tremendous assortment of photoelectric equipment with diagrams covering a wide range of applications.

Send details of your requirements or write for literature.

AUTOTRON, INC.
BOX 72290 Danville, Ill.
Representatives in principal cities

For more information circle **126** on inquiry card.

CAMBRIDGE GAMMA-RAY POCKET DOSIMETER

This personnel monitoring instrument measures the cumulative exposure to gamma or x-rays over a given period of time. The instrument consists of an ionization chamber, a quartz fibre electrometer and a graduated scale and viewing system.
The charging unit comprises a 180 volt "B" battery, a 1½ volt "A" battery, a flashlight bulb, the well for inserting Dosimeter, and the charging control.

SEND FOR BULLETIN 300 G.D.

Cambridge also makes the Lindemann-Ryerson Electrometer, with power rectifier and portable projection viewer.

CAMBRIDGE INSTRUMENT COMPANY, INC.
3554 Grand Central Terminal, New York 17, N. Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **128** on inquiry card.

HIGH-PRECISION ball & disc integrators

$90.00
MODEL 219 with standard control rod

Highest accuracy and reproducibility at lowest cost. Smooth, reliable operation for precise integration and control applications such as flow totalization, speed control, strain analysis or continuous weighing.

Write for complete engineering and applications data.

ACCURACY: ±0.1%
REPRODUCIBILITY: ±0.01%
OUTPUT TORQUE: 3 oz.-in. (higher outputs at reduced accuracy)
INPUT TORQUE: 2 oz.-in. (no output load)
CONTROL ROD: Vernier, rack, screw, or plain. Special rods designed to specification
CONTROL ROD FORCE: 3 oz. static 1 oz. dynamic
INPUT SPEED: 0-750 rpm
OUTPUT SPEED: Reversible up to more than twice the input

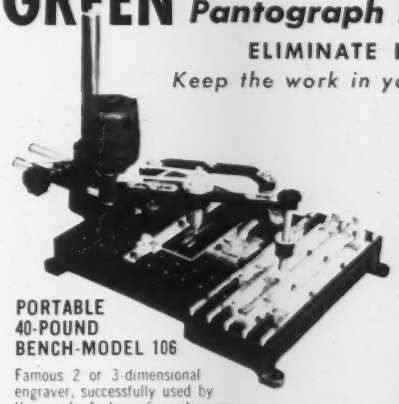
REFLECTONE

THE REFLECTONE CORP. • STAMFORD, CONN.

For more information circle **127** on inquiry card.

GREEN *Pantograph Engravers*

ELIMINATE DELAYS!
Keep the work in your own plant.



PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

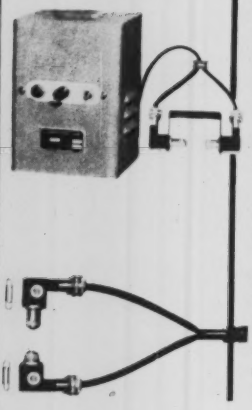
- 575 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity — master copy area 26" x 10"
- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.
383 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

For more information circle **129** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Photoelectronic Controls



Model K-1 with Miniature Photohead

This is a general purpose photoelectric control whereby the interruption of a light beam in the photohead closes a relay which can be used to activate an external circuit.

Model K-3

The K-3 control differs from the K-1 in that the output relay will not energize for each interruption of the light beam, but only if interruptions cease. Can be used to detect "flow" stoppage.

Model H-21-C

The compact, long life, *miniature* photohead . . . ideal for mounting in limited space. May be furnished with alignment brackets to insure proper relation of light source and receiver.

Decitron

ELECTRONIC PRODUCTS DIVISION

Post Machinery Co. | 159 Elliott St., Beverly, Mass.

For more information circle **130** on inquiry card.

Established 1847

QUALITY . . **OVER 100 YEARS** . . PROGRESS

Glass . . . ALL TYPES

PRECISION EXECUTION

For instrument dials and other industrial and technical uses

CLEAR COLORED SAFETY TEMPERED
HEAT RESISTING MALTESE NON-REFLECTING GLASS
INSTRUMENT LENSES PILOT LIGHT LENSES

Mirrors . . .

"EVABRITE" FIRST SURFACE MIRRORS — High reflecting hard metal coatings—direct reflection without parallax.

"EVALAST" Mirrors—silver backing protected by electroplating of copper—Eliminates deterioration through moisture, etc. Conforms to Government specifications.

We solicit your glass and mirror specifications for quotation

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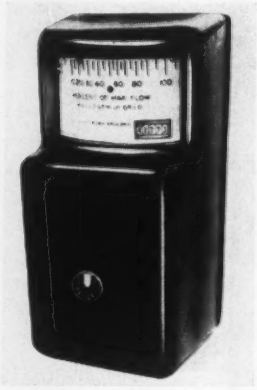
636-638 GREENWICH ST. NEW YORK 14, N. Y.
For New York—WAtkins 4-2121
For New Jersey—MArket 4-5328

For more information circle **131** on inquiry card.

FLOW INTEGRATOR

New MPT-53 Flow Integrator translates the vertical motion of a rotameter metering float into a rotary motion. Integration is accomplished



photoelectrically. Flow rate is indicated on a 4-¼" indicating scale and is totalized every three seconds on a 6-digit counter.—12-page Bulletin #170 contains details.—*Brooks Rotameter Co., P. O. Box* 432, *Lansdale, Penna.*

For more information circle **247** on inquiry card.

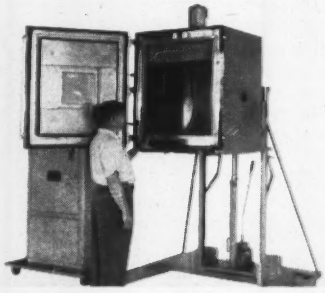
MAGNETIC RECORDING TAPE

New Magnetic Recording Tape features absolutely flat frequency response throughout the entire audio spectrum, high sensitivity and high signal-to-noise ratio. Available in gauges of ¼ mil to 50 mil, in unspliced lengths up to 7200 ft, and in widths from $\frac{1}{10}$" to 15".—*American Recording Tape Corp.*, 6363 *Wilshire Blvd., Los Angeles* 48, *Calif.*

For more information circle **248** on inquiry card.

ENVIRONMENTAL TEST CHAMBER

New portable Environmental Test Chamber, the Conrad Temp. Rac 19, is self-contained and fits into a standard 19" wide relay rack. Supplied

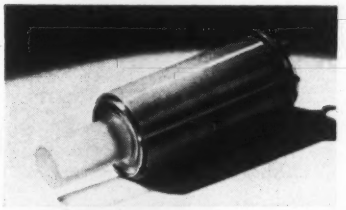


with indicating controller, it features forced-air circulator, electric heating, and direct refrigeration with patented Conrad Cascade F-13-F-22 system.—*Conrad, Inc., Conrad Square, Holland, Mich.*

For more infromation circle **249** on inquiry card.

LIQUID-LEVEL SWITCH

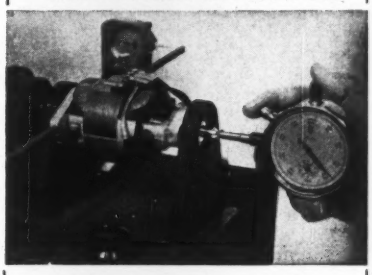
New miniature Sensing Element for low-boiling-point fluids (cryogenic applications) forms a liquid-level switching system in combination with an external miniaturized control unit. The miniature sensing element is sensitive to the presence or absence of liquid and is installed in the tank to



be monitored. No current is applied to the barium titanate transducer which is completely spark-proof. The miniaturized control unit, which is installed remotely from the monitored tank, consists of a transistor oscillator and a relay. Sensing accuracy is ± 1/64" and is not affected by vapor, foam, clinging droplets, or the viscosity and dielectric constant of the monitored liquid. Response time of the system is 25 msec max.—*Acoustica Associates, Inc., 26 Windsor Ave., Mineola, L. I., N. Y.*

For more information circle **250** on inquiry card.

SPEED CONTROL
with
THE HASLER INDICATOR



Chronometric Tachometer with separate reset button for cumulative readings

Accurate: Average ¼ of 1% of true speed through life
Automatic
Durable
Non-Magnetic
Weight, 7¾ oz.

Type A 0—20,000 R.P.M.
or 0— 6,000 F.P.M.
TYPE B 0— 2,000 R.P.M.
or 0— 600 F.P.M.

Shipment within five days from stock

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28 Vesey St., New York 7, N. Y.
U. S. Distributors for
Hasler Speed Indicators since 1919

For more information circle **132** on inquiry card.

New from...

Clary!

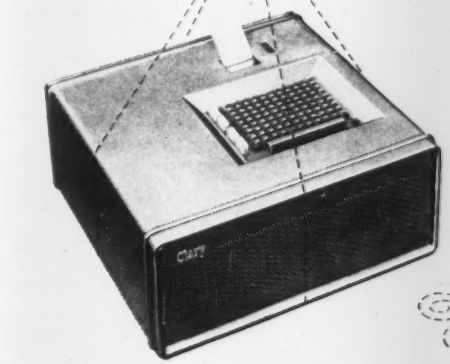
A scanning printer that operates from logical levels of both decimal and coded information!

Here at last is a fast, versatile scanning printer that draws negligible power from data sources. This unique feature allows the Clary Model 1961 printer to be used in systems that have no contact closures...lets it operate directly from logical levels of circuitry – from both decimal and coded data sources.

In addition, the Clary Scanning Printer...
prints 3 lines per second with a capacity of 12 digits per line • has an electrical selector that color prints in black and red • comes with a manual input keyboard as standard equipment • has fewer moving parts...insures reliability.

For more information on the Clary Model 1961 Scanning Printer, write today for Engineering Bulletin No. S-111.

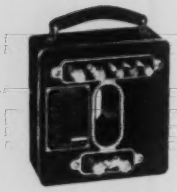
Clary Corporation
Electronics Division
San Gabriel, California



For more information circle **133** on inquiry card.

HANDY ACCESSORIES

for Graphic Instruments



Model D, Portable, 7-range Current Transformer. Bulletin 155A.

Chart Inspector

This handy device makes it easy to inspect and make notes on E-A record charts. Catalog Section 80.

Split-core current transformers are made in 5 frame sizes. Ranges from 25 to 6000 amperes primary. Bulletin 255A.

Other Accessories to Make Recording Easier

Ammeter and Wattmeter shunts, Kva-Kvar phase-shifting transformers, double potential and isolating transformers, step-up potential transformers, chronograph pens, binding posts, carrying cases, quick connectors, cable clamps—all are described in Catalog Section 80.

Ask for Bulletins 155A, 255A and Catalog Section 80

Product Representatives in Most Principal Cities

The ESTERLINE-ANGUS Company, Inc.

Pioneers in the Manufacture of Graphic Instruments

Dept. G, P. O. Box 596, INDIANAPOLIS 6, INDIANA

For more information circle **134** on inquiry card.

MEASURE DELAY ACCURATELY

without JITTER*

WITH TLI's NEW

PULSE TIMER

MODEL PT244 $1895.00

WHAT IT IS —

. . . a paired trigger generator with fixed and delayed pulses. Combination of counters and digital dial provides direct reading delay to 9,999.99 microseconds accurate to better than 0.01 microsecond. Note that this instrument is a full size module of the TLI Modular Instrumentation System.

Incorporates design of Hazeltine Electronics Corp. Model L754 Precision Time Measuring Equipment.

HOW IT WORKS —

Delay controls position gates which select desired pulse from 100kc crystal controlled pulse chain to avoid jitter inherent in delay circuits. Phantastron circuit provides vernier control between 10 microsecond pulses. Jitter less than 0.001 microsecond.

Full specifications and application information available on request in Bulletin WC-8.

TELETRONICS LABORATORY, INC.

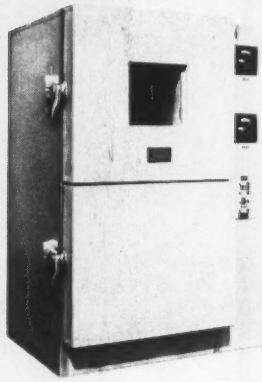
54 KINKLE STREET
WESTBURY, L. I., N. Y.

For more information circle **135** on inquiry card.

NEW INSTRUMENTS

ENVIRONMENTAL CHAMBERS

New vertical Hot-Cold-Humidity Chambers use dry ice in compartment located under the test chamber. Range is −90° to +240°F (and up to 425° F, if desired); humidity ranges from



20% to 95% easily can be obtained. Other features are an interior chamber fan to insure even temperature within the chamber, a circulating fan, easily adjustable dry bulb and wet bulb thermostats, and two heat control.—*Development Engineering Co., Inc., 9 Cross St., Norwalk, Conn.*

For more information circle **251** on inquiry card.

PRESET ELECTRONIC COUNTER

New transistorized Model 37 Counter is for use (1) as a preset counter for counting, batching and sorting applications, (2) as a rate divider and variable-pulse-rate generator and (3) as a variable-pulse delay unit. Count range is 1 to 10,000 at counting rates up to 100 kc.—*CK Components, Inc., 101 Morse St., Watertown, Mass.*

For more information circle **252** on inquiry card.

HIGH-SPEED MULTIPLEXER

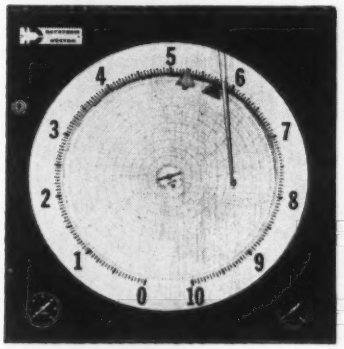
New high-speed Multiplexer, Model 115, completely self-contained with power supply, features transistorized plug-in units. Maximum rate of multiplexing is 20,000 samples/sec, ten

separate channels can be sampled at a rate of 2,000 samples/sec per channel. The unit can be driven either externally or internally. The number of channels, the frame rate and sample rate, are crystal controlled, and can be selected by rotary switches located on the front panel of the multiplexer.—*Digital Instrument Labs., 152 South Atlantic Blvd., Los Angeles 22, Calif.*

For more information circle **253** on inquiry card.

CIRCULAR-CHART RECORDERS

New circular-chart Recorder-Controllers, with either electric or pneumatic controls, feature the recently-developed D-Pak constant-voltage supply unit (which eliminates batteries, standard cells, and standardizing mechanisms in potentiometers); interchangeable slide-wires; easy replaceable range standards; plug-in amplifiers; universal mountings; and re-



cessed indicator pointers to facilitate chart replacements. Pneumatic controls—in Models 6836 (potentiometer) and 6856 (Wheatstone bridge)—are available with all modes: (Proportional band adjustability is 2 to 300%). Electric controls—in Models 6833 (potentiometer) and 6853 (Wheatstone bridge)—are available as contact type (two-position or three-position) and proportioning control with 5, 10, or 20% proportional band. Accuracy is ± 0.25% of span, or 0.025 mv. Full-scale response time is 5, 10, and 20 sec. Standard chart speeds are 7 days, 48, 24, 12, 8, 4, or 1 hour/rev.—*Daystrom-Weston Industrial Div. of Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.*

For more information circle **254** on inquiry card.

DUAL-BEAM OSCILLOSCOPE

New Type 411 Dual-Beam Oscilloscope plots two dynamic functions against one another, or either of the

two functions simultaneously against time. Outputs from the majority of transducers can be displayed without preamplification.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

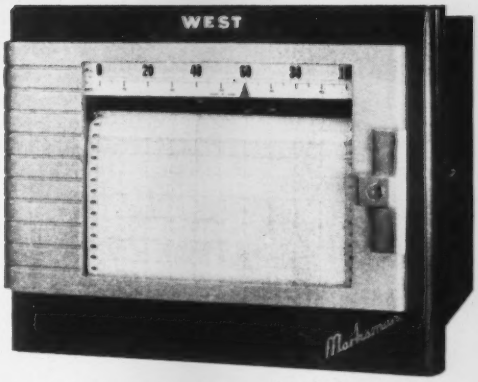
For more information circle **255** on inquiry card.

Still hitched to horse-and-buggy recorders?

Boost volume...
assure quality...
control costs
with

Marksman

Tubeless Strip-Chart Potentiometer Recorders



Transistorized, these precise instruments avoid *all* the notorious tube-troubles. Needing no warm-up, adjustment, replacement of tubes or repair of their circuitry, Marksman recorders permit immediate and *continuous* operation...so increase production.

Accurate within 1/5th of 1%, they also include several special features which provide for more user-convenience and consistent quality-control. Users in many lines report Marksman recorders involve less operational cost, as well as reducing waste of other factors.

Let our world-wide service help on your own job. Phone your West consultant (see Yellow pages) or write Chicago office for Bulletin M.

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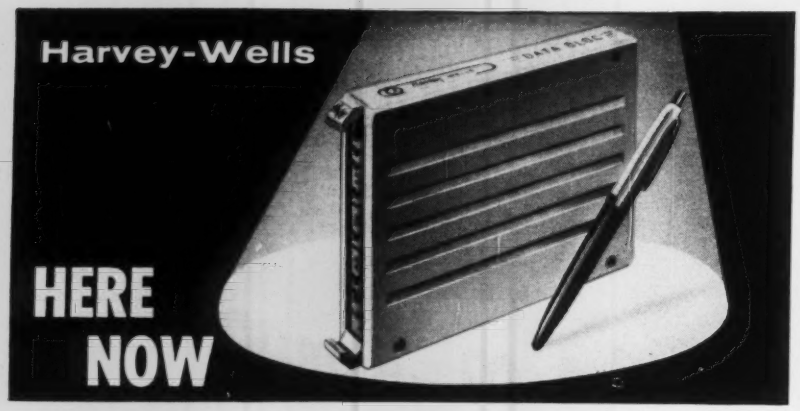
52 Regent St., Brighton 1, Sussex

the trend is to **WEST**

For more information circle **136** on inquiry card.



5 mc Data Bloc • Data-Pac

Versatile, High-Speed digital building blocks for data handling, data conversion systems . . . special purpose counters . . . process control and automation . . . laboratory research and test equipment.

NMR instrumentation, electromagnets and power supplies, error signal comparator . . . digital components.

HARVEY-WELLS ELECTRONICS, INC.
Research and Development Division
5168 WASHINGTON ST., WEST ROXBURY 32, MASS.

For more information circle **137** on inquiry card.

ELECTRONICS BOOKS

The Computer Handbook
edited by M. H. Aronson. A clear introduction to the entire field of electronic computers and data processors. Presentations by computer manufacturers at the Second Computer Clinic. Paperbound, 72 pages, 1956. $2.00

100 Electronic Circuits
by M. H. Aronson and C. F. Kezer . . . covers amplifiers, oscillators, pulse circuits, phase shifters, etc. Complete with all circuit component values and response specifications. Paper, 180 pages $2.00

Strain Gage Instrumentation
edited by Aronson and Nelson. ". . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages." Paper, 110 pages, illustrated, indexed by company, author, and subject, 1958. $2.00

INSTRUMENTS PUBLISHING CO.
845 RIDGE AVENUE
PITTSBURGH 12, PENNA.

TANK-O-METER
FOR MEASURING TANK CONTENTS
ANY DISTANCE AWAY

TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM
SEND FOR BULLETINS

Also gauges for:
Barometric Pressure (Mercury Column)
Absolute Pressure (Mercury Column)
Pressure and Vacuum
Differential Pressure
Inclined Manometers for draft, pressure or differential pressure.

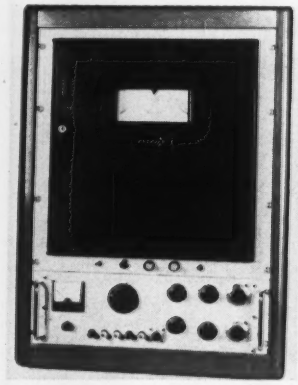
UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

For more information circle **139** on inquiry card.

NEW INSTRUMENTS

STRAIN INDICATOR

New LC-261 automatic Strain Indicator features the resolution (0.005%), linearity (0.02%), repeatability (0.01%), and absolute accuracy (0.05%) required of a precision standard for calibration and linearity test-



ing of high-quality strain-gage transducers. Instrument calibration is continuously adjustable from 1 to 15 mv/v and is independent of input and output impedance within the range of 60 to 1000 ohms.—Bulletin 105 contains details.—*Bytrex Corp.*, 294 *Centre St., Newton* 58, *Mass.*

For more information circle **256** on inquiry card.

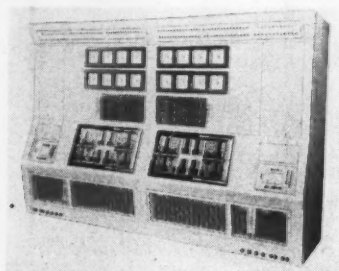
PROGRAMMING SYSTEM

New POGO system (Program Optimizer for G-15 Operations) automatically rewrites instructions fed into the computer in its own machine language and punches it into paper tape. Data are handled in decimal form, with numbers of seven digits, positive or negative.—2-page Bulletin AR-118 gives details.—*Bendix Computer Div.*, 5630 *Arbor Vitae St., Los Angeles* 45, *Calif.*

For more information circle **257** on inquiry card.

ANALOG COMPUTER

New Dian 120, a 120-amplifier Computer, stresses high precision and reliability. Amplifier has low drift (25

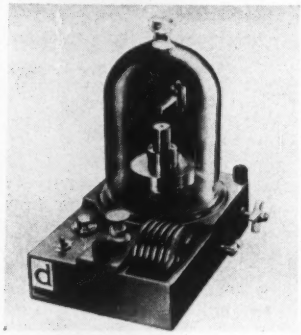


μv), grid current is less than 30 μ-μamps and noise is 0.25 mv. The Dian 120 is offered for sale or for lease.—*Dian Laboratories, Inc.*, 611 *Broadway, New York* 12, *N. Y.*

For more information circle **258** on inquiry card.

PRIMARY PRESSURE STANDARD

New Pneumatic Gage Tester for use as an accurate primary standard in gaging and calibrating of all pressure instruments features an unusual



range of pressures with provision for any pressure-reference between 0 psia and 500 psig, and accuracy of 0.015% of full scale.—*Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.*

For more information circle **259** on inquiry card.

ELECTRONIC TACHOMETER

New Dynacounter Digital Tachometer covers the range of engine speeds from 1/5 rpm to 50,000 rpm; reads speed to one revolution in 1/10 sec.

within 10 rpm in 1/100 sec, at all speeds. By using low-torque gearless Rotopulser, 20 to 20,000 rpm con be measured without any operating adjustments. Has in-line "Nixie" digital readout with cold-cathode decade counter tubes optional. Display time: 1/10 to 5 sec and hold; sensitivity: 1 mv rms.—*Dynapar Corp.*, 5150 *Church St., Skokie, Ill.*

For more information circle **260** on inquiry card.

PHOTOGRAPHIC PAPERS

New Kodak Linagraph Recording Papers have a relative tungsten speed of 100 (Linagraph 77) and 20 (Linagraph 44), respectively. Both feature (1) simplicity (because they do everything formerly required by several papers), (2) emulsions coated on a specially-treated paper base for maximum strength, durability, and trace reproducibility. Traces are sharp, black and readable throughout. The papers are available in all width and maximum lengths to fit every oscillograph.—*Eastman Kodak Co., Photo Recording Methods Sales Div., Rochester 4, N. Y.*

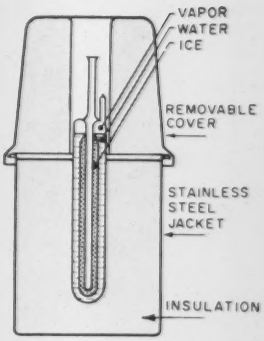
For more information circle **261** on inquiry card.

New Temperature Standard

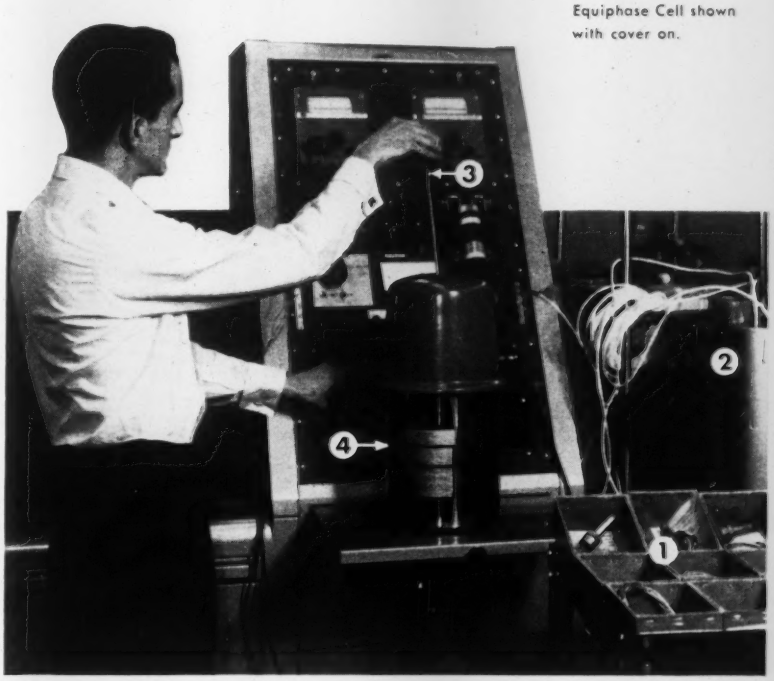
TRANS-SONICS T.M.

EQUIPHASE* CELL

assures accuracy of thermometer calibrations



Equiphase Cell shown with cover on.



The above photograph shows how an Equiphase Cell is used to assure accuracy in calibrating platinum resistance thermometers. Various types of platinum thermometers (1) to be calibrated are immersed in an ice bath (2). The temperature of the ice bath is continuously monitored by a special platinum thermometer (3) used as the working standard. Accuracy of the working standard is assured by periodic checking against the reference temperature established by the Equiphase Cell (4).

In the Equiphase Cell, pure water is partially frozen in an evacuated and noncontaminable sealed glass system to establish the triple-point-of-water (ice, water, and water-vapor at 4.58 mm Hg). By definition the triple-point-of-water is a fundamental fixed point at exactly 0.0100C on the International Temperature Scale. Equiphase Cells, meeting these exacting requirements,are now available in a convenient easy-to-use package complete with instruction booklet. Write for Equiphase Cell Technical Bulletin to Trans-Sonics, Inc., Dept. 19, Burlington, Massachusetts.

TRANS-SONICS

Precision Transducers

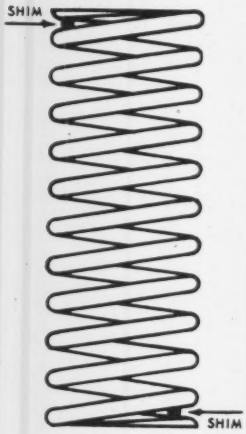
*TRADEMARK

For more information circle **140** on inquiry card.

it's the shim that counts
in

CHATILLON COMPRESSION SPRINGS

Available in practically all sizes and capacities



Chatillon's compression springs with calibrated shims—an original Chatillon development—perform so accurately, they are specified in the precision instruments of leading manufacturers: e.g.: General Electric (ordnance equipment), Bendix (pressure transmitters), Chandler-Evans (aircraft carburetors). Shims brazed on the end coils of this spring maintain constant number of active coils during compression, thereby insuring constant rate. Straight line relationship between load and deflection is considerably improved. This great increase in accuracy, costs no more! Chatillon compression springs are available in Iso-Elastic* (Chatillon's own temperature-compensated alloy) or other spring alloys. Chatillon also manufactures Spiral, Torsion and Form Springs in Iso-Elastic and conventional alloys.

Have Chatillon's Spring Division show you how easily you may improve the accuracy of your instruments. Write for engineering bulletins.

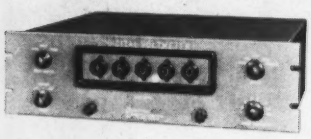
*U.S.A. Pat. No. 2174171

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK 38, N.Y.
Manufacturers of Scales, Force Measuring Instruments and Precision Springs Since 1835

For more information circle **141** on inquiry card.

DIGITAL VOLTMETER

New all-electronic Digital Voltmeter, Model 8409, capable of making 50 measurements/sec, features totally-transistorized logic circuits; ± 1 digit

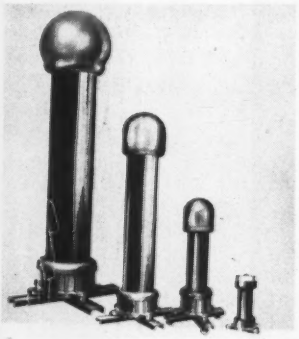


accuracy; automatic polarity; automatic, manual and remote ranging; 1,000 megohm input impedance; BCD and decimal output; direct printer operation; provision for external reference voltage; and modular construction throughout.—*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego* 11, *Calif.*

For more information circle **262** on inquiry card.

COMPRESSED-GAS CONDENSER

New imported Hartmann & Braun Lossfree Compressed-Gas Condensers, designed for filling of nitrogen or carbon dioxide (working pressure 200 psi), feature a screened low-voltage electrode, and are manufactured in 4



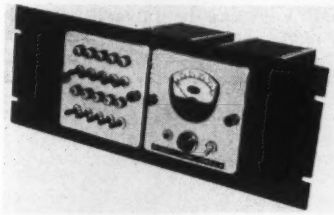
sizes: 120 kv, 250 kv, 500 kv and 800 kv. The pressure unit consists of a gas-tight compressed bakelized tube. They are used for high-tension-loss angle-measuring bridges as standard capacities for measuring the dielectric loss factor of condensers, cables, insulators, bushings, etc.; also for measuring the capacity and the dielectric constant of insulation materials and high tension equipment.—8-page Booklet EM24-2e gives details.—*EPIC, Inc.*, 154 *Nassau St., New York* 38, *N. Y.*

For more information circle **263** on inquiry card.

TEMPERATURE MONITORING SYSTEM

New thermistor-type Temperature Monitoring System, capable of monitoring a virtually unlimited number of points continuously without scanning, features modular construction and solid-state components. Applications include monitoring bearing temperatures in generators, turbines, pumps and other rotating equipment;

as well as temperature protection for processes, processing equipment, pipelines, and all types of industrial installations. Range is from −25 to + 600°F. For normal applications a



transistorized amplifier is furnished. For applications under extraordinary service conditions, a hermetically-sealed magnetic amplifier can be supplied optionally.—*Fenwal Incorporated, Ashland, Mass.*

For more information circle **264** on inquiry card.

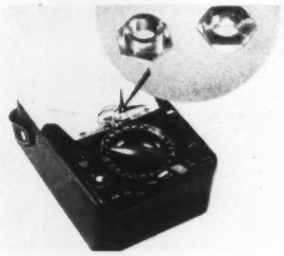
DIGITAL LINEAR POSITIONER

New Digital Positioner, requiring no servo-components or follow-up systems, can be employed in combination with recording controllers, analog, computers, digital computers, or simple manual remote control stations. Control principle: A nominal number of control stage cylinders are employed with each cylinder stroke, proportioned to conform to the binary progression. By programming (sequencing or selecting) each cylinder to operate conforming with the binary progression, extremely precise incremental control is obtained.—*Ferguson, Hille & Associates, Inc.*, 542 *South Dearborn St., Chicago* 5, *Ill.*

For more information circle **265** on inquiry card.

MINIATURE JEWEL NUTS

New brass or aluminum Miniature Nuts (called "jewel" nuts because of their size and accuracy) are supplied to customers' specifications with standard or special threads (No. 0 and larger) in diameters as small as ⅛" hex,



tapped square with faces, countersunk on both sides, burrless, degreased, in either single or double-chamfered styles and special shapes. Lengths and diameters are held to +0.000" and −1.005", which are closer tolerances than the American Standard B18.2-1955 specs. Illustrated is a typical application in the Model 631 VTVM-VOM testing instrument by Triplett Electrical Instrument Co.—*Fischer Special Mfg. Co.*, 498 *Morgan Ave., Cincinnati* 6, *Ohio.*

For more information circle **266** on inquiry card.

RUGGED and RELIABLE

New!

TRANSISTORIZED

The A. W. HAYDON COMPANY'S TRANSISTORIZED SUB-MINIATURE ELECTRONIC TIME DELAY RELAYS!

SAVE SPACE AND WEIGHT!

	Miniature Series	Sub-Miniature Series
Cross Section	1 7/16" x 1 21/32"	3/32" x 1 3/16"
Length	2 1/4" long	2" long
Weight	6 ounces	3 ounces
WRITE FOR:	Bulletin AWH TD-503	Bulletin AWH TD-504

TEST-PROVED PERFORMANCE!
High Temperature: 125°C (250°F)
Vibration: 2000 CPS at 15 g.
Contact arrangements up to 4 pole double throw.
Unique transistorized R.C. time constant network.
Time Delays from 50 MS to 120 seconds. Longer Delays available.
Hermetically sealed housings.

MEET REQUIREMENTS OF MIL-E-5272A.

The A. W. HAYDON Company

228 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

See us in Booths 2702-2704 at the 1959 IRE Show.

For more information circle **142** on inquiry card.

OPTICS

LAMINATED & SOLID GLASS FILTERS
INDUSTRIAL • SCIENTIFIC • PHOTOGRAPHIC

PRECISION OPTICS
WINDOWS • PRISMS • WEDGES

SPECIALIZED GLASS
VYCOR • PYREX • QUARTZ

PRECISION HOLE DRILLING
TOLERANCES TO .0001"

PRECISION EDGING SAWING, MACHINING
ON ALL TYPES OF GLASS & CERAMICS

PRECISION OPTICAL MACHINING
METAL LENS MOUNTS • BARRELS • EYEPIECES

AUTOMATIC SCREW MACHINES TO 4" DIA. — ALSO HAND SCREW MACHINES — ENGLISH & METRIC THREADS OUR SPECIALTY.

Write for Filter Transmission Curve Catalog.

Tiffen QUALITY PRODUCTS

TIFFEN OPTICAL CO.
INDUSTRIAL DIVISION
71 Jane St., Roslyn Heights, L.I., N.Y.

For more information circle **143** on inquiry card.

NEW

Sea Water Depth PRESSURE TRANSDUCERS

Sonar Submarine Torpedo Applications

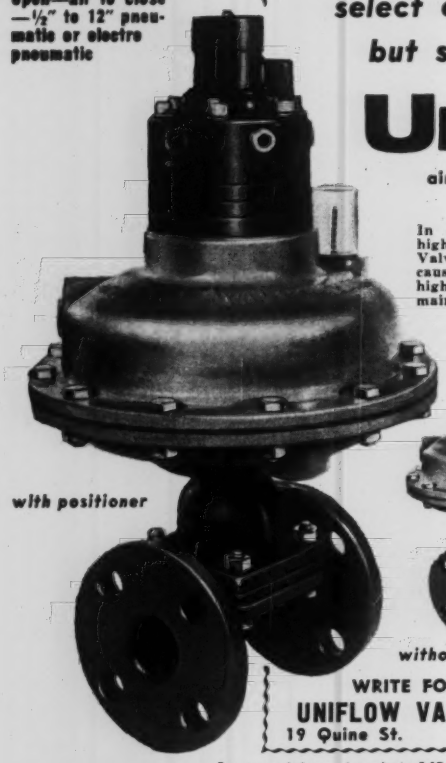
- Input: sea water pressure
- Output: volts, a-c or d-c
- Hermetically sealed case
- Patented angle-wipe potentiometer
- 1000-hour service life

Ranges: 0-50 to 0-7500 feet

COLVIN LABORATORIES, INC.
364 Glenwood Avenue, East Orange, N. J.

For more information circle **144** on inquiry card.

Uniflow Springless type 500 air to open—air to close —½" to 12" pneumatic or electro pneumatic



select either type

but select . . .

Uniflow

air operated Saunders patent type control valves

In chemical, slurry, water treating and high vacuum installations, UNIFLOW Valves are fast becoming most popular because not only are they low in cost, but highest quality requirements are met and maintained.

Uniflow Air Operated Control Valves employ Saunders patent valve features—the valve that requires no stuffing box or stem packing.

Why not learn how you can fill your difficult control valve needs quickly—economically.

WRITE FOR BULLETIN 114R

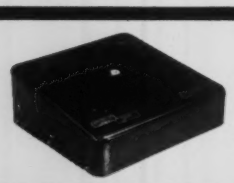
UNIFLOW VALVE CORPORATION

19 Quine St. Cranford, New Jersey

For more information circle **145** on inquiry card.

TURNTABLE DEGAUSSER

semi-automatic — total erasure



for all instrumentation tapes and magnetic films

The MAGNASYNC Model A-937 DEGAUSSER features a predetermined 20-second timed cycle that completely eliminates guesswork. The pushbutton-controlled motor-driven turntable insures fast and complete bulk erasure and eliminates noise patterns which are generated by irregular rotational motion. **$159.50**

Model M-937 MANUAL DEGAUSSER — smooth, free-wheeling turntable, will not damage edges of instrumentation tapes or films . . . **$119.50**

Model G-936 CONVENTIONAL DEGAUSSER — an effective bulk eraser economically priced . . . **$69.50**

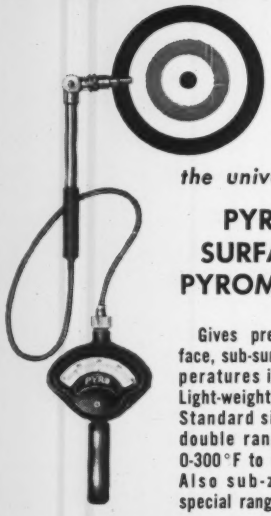
immediate delivery

MAGNASYNC Manufacturing Co., Ltd.

5542 Satsuma Ave., North Hollywood, California

For more information circle **146** on inquiry card.

UNEXCELLED ACCURACY



the universal

PYRO SURFACE PYROMETER

Gives precise surface, sub-surface temperatures instantly. Light-weight, rugged. Standard single and double ranges from 0-300°F to 0-1500°F. Also sub-zero and special ranges.

Send for FREE catalog No. 168.

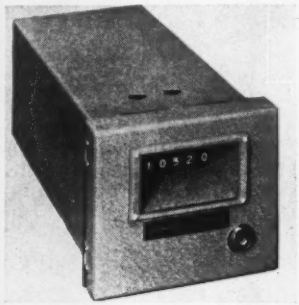
PYROMETER INSTRUMENT CO., INC.

BERGENFIELD 4, NEW JERSEY

For more information circle **147** on inquiry card.

DIGITAL SERVO INDICATOR

New Model 143 Digital Servo Indicator, based on a continuous null-balance servo system, indicates quickly and accurately forces, fluid flow, weights, or rpms which can be converted into a-c or d-c millivolts. Also facilitates measurement of any linear



variable where values change throughout a wide range and where precise, fast evaluation and good resolution are vitally important. Typical applications are the measurement of fuel flows and thrusts of jet engines on static test stands.—Two 2-page bulletins (D-103 and D-104) give details. —*Gilmore Industries, Inc.,* 13015 *Woodland Ave., Cleveland* 20, *Ohio.*

For more information circle **267** on inquiry card.

THERMO-REGULATORS

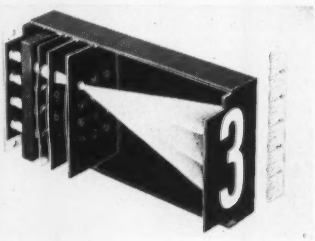
New Red-Top Thermo-Regulators are adjustable mercury-to-tungsten thermostats, operating within ±0.05°F over range from −38°F to

+350°F. Two types are available: No. 7530 with a range of 75°F to 350°F for heating cycles; and No. 7540 with a range of −35°F to +70° F for cooling cycles. Approximately 11" long, they have a ½" dia stem.—*H-B Instrument Co., American & Bristol Sts., Phila.* 40, *Pa.*

For more information circle **268** on inquiry card.

PROJECTION-TYPE READOUT

New Series 80,000 In-Line Display (approximately four times the size of the company's standard unit) features three lenses (two condensing lenses plus one projection lens). Thus the entire viewing screen is illuminated. Size of the digit or character displayed is 3-¾" high by 2" wide.



Other features include single-plane in-line presentation and no moving parts.—*Industrial Electronic Engineers Inc.*, 3973 *Lankershim Blvd., North Hollywood, Calif.*

For more information circle **269** on inquiry card.

COMMERCIAL PROGRAMMERS

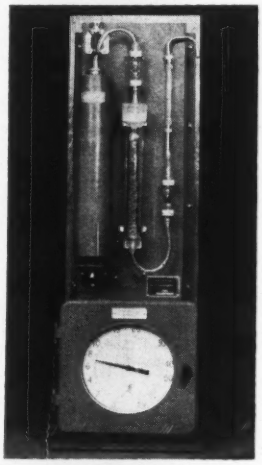
New series of electrical Programmers offers versatility in solving complex electrical switching problems for vending machines, appliances, automation controls, industrial programming, advertising displays, and numerous

other applications. Design includes: from one to eight SPDT snap-action switches; wide range of cycling times (from 30 sec to 24 hours/cycle); and quick-connect terminals to facilitate rapid installation.—2-page Bulletin AWH RC-202 contains full specifications.—*A. W. Haydon Co.*, 232 *N. Elm St., Waterbury* 20, *Conn.*

For more information circle **270** on inquiry card.

DISSOLVED-OXYGEN ANALYZER

New Oxygen Analyzer, utilizing the unique property of thallium of being extremely reactive with traces of oxygen and at the same time being inert to water, consists of a mixed bed demineralizer cartridge and a packed column of pure thallium. The elec-



trical conductivity of the water is measured before and after the thallium column, the water sample being first passed through the mixed-bed demineralizer.—*Industrial Instruments Inc.*, 89 *Commerce Road, Cedar Grove, N. J.*

For more information circle **271** on inquiry card.

MOST MAJOR U.S. POWER PRODUCERS REDUCE COSTS with PANALARM ANNUNCIATORS

MAXIMUM INFORMATION on all process variables . . . the result of 10 years system engineering by Panalarm and major power producers. That's why Universal Series 50 is the power industry's most informative annunciator. Trouble anywhere is signalled instantly—*before* it can grow big and expensive. "Off-normals" are pinpointed instantly, accurately for fast remedial action, reducing costly "outage" losses.

Economical, highly flexible design facilitates system expansion. Can be simply adapted to your exact requirement, avoiding costly custom designing. Proven components—e.g., almost 1,000,000 dependable Panalarm developed relays have been used in Panalarm annunciators.

Ask your nearby Panalarm sales engineer to show you why Universal Series 50 is the power industry's No. 1 annunciator choice . . . how its adaptablility and reliability can help increase your profits . . . by producing maximum information and reducing costly "outages." No obligation, of course.

Write for Catalog 100 B today.

PANALARM®

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PANELLIT, INC.

7401 NORTH HAMLIN AVENUE • SKOKIE, ILLINOIS

For more information circle **148** on inquiry card.

ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

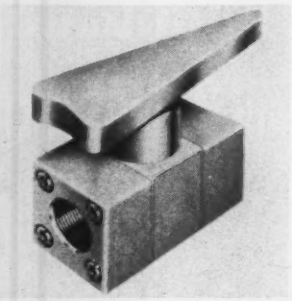
For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 265 East Park Drive, Buffalo 17, New York.

For more information circle **149** on inquiry card.

NEW INSTRUMENTS

BALL VALVE

New 3000-psi Flo-Ball Valve with zero leakage and one quarter turn positive opening and shut-off can replace conventional needle valve. De-

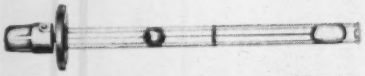


signed for panel-, bracket-, or line-mounting, the valve takes a variety of end fittings. Features are straight-through flow; and self-lubricating, self-lapping and self-wiping characteristics.—*Hydromatics, Inc.*, 70 *Okner Parkway, Livingston, N. J.*

For more information circle **272** on inquiry card.

LIQUID-LEVEL CONTROL

New Model KT Tandem Control for two electrical signals (at high and low level) is made with explosion-proof housing, and offers the advan-

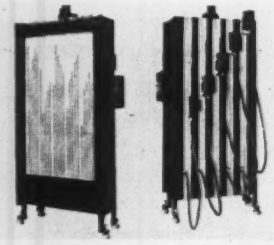


tages of a float-operated control. Also available for external installation when ordered with float chamber.—*Jo-Bell Products, Inc.*, 5456 *West 111th St., Oak Lawn, Ill.*

For more information circle **273** on inquiry card.

PHOTO-MANOMETER

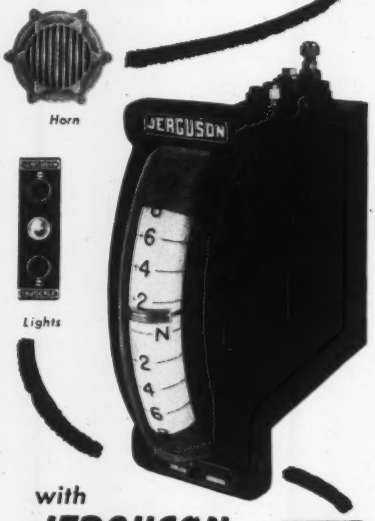
New Photo-Manometer with 25 indicating tubes of 50" range, permits photographic records of 25 simultaneous pressure readings. Of 5 wells at



the rear, each serves a group of 5 adjacent tubes. Maximum working pressure is 350 psig. Tubes and scales (of translucent plastic with opaque graduations in inches and tenths) are evenly lighted from the rear by fluorescent lamps inside the steel cabinet.—*King Engineering Corp., Box* 712, *Ann Arbor, Mich.*

For more information circle **274** on inquiry card.

You Get
COMPLETE PROTECTION



with
JERGUSON TRUSCALE
Remote Reading
GAGES

Truscale shows ACCURATE Liquid Level (to ½ of 1% of scale) and REPEATS, REPEATS, REPEATS, REPEATS, REPEATS, in up to 6 auxiliary locations with Truscale Repeaters (miniature copies of Truscale)

Convex Scale . . . full 180° visibility.

Get complete protection for your valuable boilers and tanks. Ask for Truscale Catalog showing Standard, Inclined and Red Flasher Truscales in all WSP.

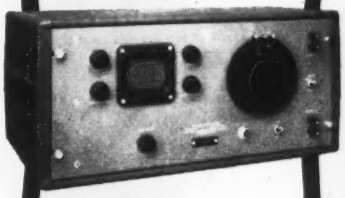
JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

For more information circle **150** on inquiry card.

TYPE 706-A ULTRA-SONIC PRIMARY PHASE STANDARD



FEATURES:

- ±0.1° Phase Shift Accuracy
- 20 kc to 200 kc Frequency Coverage
- 0° to 360° Continuous Phase Shift
- Self-Calibrating
- Long-Term Operating Reliability
- Lissajous Pattern Presentation

Description . . .

The Type 706-A Ultra-Sonic Primary Phase Standard generates two sinusoidal voltage signals whose phase difference can be varied smoothly from 0° to 360° with an accuracy of 0.1°. Units are built for any single frequency from 20 kc to 200 kc. Operation of the Type 706-A is based on the interpretation of a multiple-frequency Lissajous pattern.

Specifications . . .

Frequencies: Any single frequency from 20 kc to 200 kc.

Output Voltage Range: 5 to 10 volts (rms).

Output Impedance: Approximately 200 ohms (from cathode follower).

Phase Stability: ±0.2° per hour at 25°C ambient temperature after a warm-up period of 2 hours.

Power Supply: 105-125 volts, 60 cycle electronically-regulated, self-contained supply, requiring approximately 150 watts.

For full details and specifications, wire or call

ACTON LABORATORIES, INC.

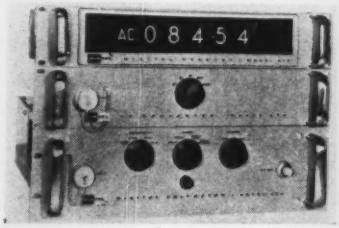
521 Main Street, Acton 9, Mass.

COlonial 3-7756

For more information circle **151** on inquiry card.

AC/DC DIGITAL VOLTMETER

New Model 502 Digital Voltmeter with a-c converter provides full four-digit accuracy across all a-c and d-c ranges. In addition, a fifth digit indicating either "0" or "1" doubles each d-c range, increasing the top numerical limit from 9999 to 19999. Auto-

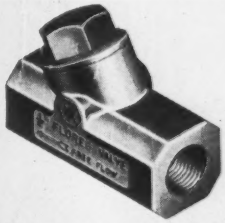


matic switching from range to range is provided for d-c voltages. Automatic ranging of a-c signals is also available as an optional feature by using a different a-c converter. Overall range for d-c is ± 0.0001 to 1000.0 v; for a-c: 0.001 to 999.9 v, 30 to 10,000 cps. Accuracy is 0.01% ± 1 digit for dc, 0.2% ± 1 digit for ac.—*KIN TEL Div., Cohu Electronics, Inc.*, 5725 *Kearny Villa Rd., Box 623, San Diego 12, Calif.*

For more information circle **275** on inquiry card.

FLOW CONTROL VALVE

New Floreg Valve controls the rate at which a gas or a liquid can flow in one direction through a circuit, yet allows free flow in the opposite direction. Easily adjustable in minute



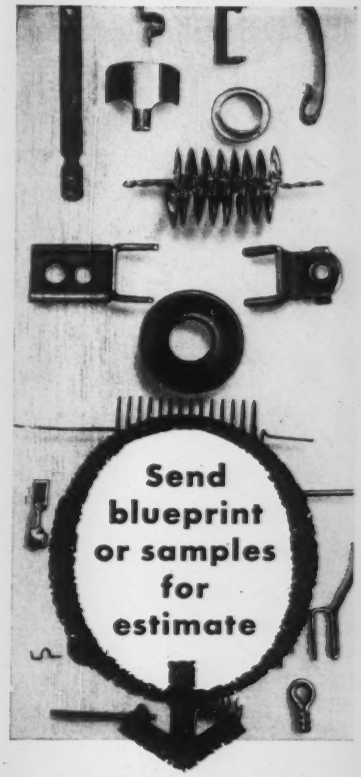
steps to "full flow," a single flow passage eliminates leakage encountered in the separate check-valve-type design. Maximum working pressure—250 psi pneumatic, and 500 or 2000 psi hydraulic. Available sizes: ¼", ⅜" and ½" NPT.—2-page Catalog D6-105.01 contains details.—*Westinghouse Air Brake Co., Industrial Products Div., Wilmerding, Penna.*

For more information circle **276** on inquiry card.

AUTOMATIC TANK GAGE

New Ground Reading Automatic Tank Gage, Fig. 2500G, can be added to 16-foot small bolted low-pressure tanks in service. It may be purchased with either guided or unguided float. No welding is required during the installation; all fittings are bolted to the tank. Bottom guide wire anchor and float can be installed through an existing hole (Gage Hatch).—*Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.*

For more information circle **277** on inquiry card.



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Perfect straight lengths to 12 feet.
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Specializing in production of parts for electronic, cathode ray tubes and transistors.

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For more information circle **152** on inquiry card.

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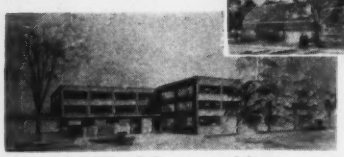
For more information circle **153** on inquiry card.

new plants and mergers

Kearfott


Standard Electric Time

KEARFOTT CO. is adding a million-dollar two-story building to its facilities in West Paterson, which will enclose about 100,000 sq ft of floor space.

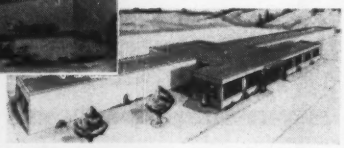
STANDARD ELECTRIC TIME CO. has a 34,000-sq-ft addition to its plant under construction.

NEPTUNE METER CO. has formed a new Electro-Mechanical Division from its wholly-owned subsidiaries: Revere Corp. of America, Electronic Signal Co., and Hot Spot Detector, Inc.

DATEX CORP. has drawn up plans for a new engineering building which will increase working area by 70%.

JOHN FLUKE MFG. CO. is building a new plant with approximately 18,000 sq ft space at Mountlake Terrace just north of Seattle.

Datex Corp.


John Fluke

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Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

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- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

WRITE TODAY FOR COMPLETE INFORMATION

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

For more information circle **154** on inquiry card.

FOR LEAK-DETECTION DEVICES

OHIO
NITROUS OXIDE
EASILY SNIFFS OUT MICROSCOPIC LEAKS

Infrared determination of nitrous oxide provides a safe, sensitive and flexible method of leak detection. This method is not affected by usual atmosphere components such as moisture, carbon dioxide and hydrocarbons. In addition, nitrous oxide will not harm pieces being tested and is more economical than other gaseous agents.

OHIO NITROUS OXIDE: ODORLESS AND INERT • NONTOXIC • NONCORROSIVE • NONFLAMMABLE • ECONOMICAL

FREE TECHNICAL AID is available in the use of nitrous oxide for leak detection. For further information, please request the following bulletins:

1A Chemical, Physical and Pharmacological Properties of Nitrous Oxide with Results of Corrosion Tests
1B Gas Service Equipment for Nitrous Oxide Supply

OHIO *Ohio Chemical*
OHIO CHEMICAL & SURGICAL EQUIPMENT CO.
(A Division of Air Reduction Company, Incorporated) AIRCO
MADISON 10, WISCONSIN

For more information circle **155** on inquiry card.

TECHNOLOGY INSTRUMENT CORP. announces extension of the facilities of its subsidiary, Technology Instrument Corp. of California, by 24,000 sq ft, and doubling of the present floor space of Acton Laboratories.

GLENNITE BATTERY DISTRIBUTORS, a new national sales organization, will be agents for the rechargeable nickel-cadmium button cell batteries.

people in the news

B. Price

A. D. Rose

D. E. Root

FISHER GOVERNOR CO. announces appointment of *Colonel Bruce Price* as export manager.

JAS. P. MARSH CORP. has elected *A. D. Rose* to the position of president.

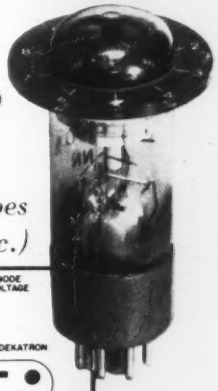
CUBIC CORP. has appointed *Donald E. Root* general manager of its newly formed Industrial Division.

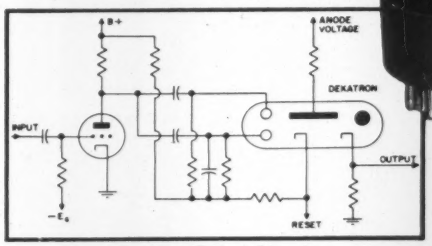
BAUSCH & LOMB announces election of *William W. McQuilkin* as president and *Carl C. Hallauer as* chairman of the board.

Simplify Circuitry using

dekatron®

Electronic Counting Tubes (up to 20,000 counts/sec.)





Typical Drive Circuit

As a user of DEKATRON cold cathode glow-transfer counting tubes, you are welcome to use this and many other drive circuits designed by us. Circuits are patented (or applied for) but are available to DEKATRON customers on a royalty-free basis.

Write to us for complete information.

Baird-Atomic, Inc.
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Instrumentation for Better Analysis

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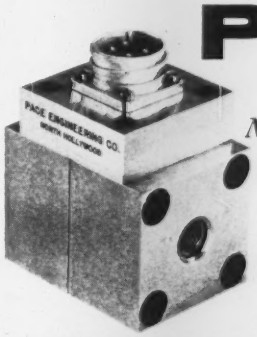

Magnetic Reluctance

PRESSURE TRANSDUCER MODEL P3D

RANGES AS LOW AS ±1/10 PSID
MAXIMUM LINE PRESSURE 5000 PSI

- **MAXIMUM OVERPRESSURE:** 200 psid or 200% range.
- **EXTREMELY CORROSION RESISTANT.**
- **INSENSITIVE TO SHOCK AND VIBRATION**—not oil filled.
- **ACCEPTS CORROSIVE FLUIDS BOTH SIDES**—all stainless exposure.

Write for your copy of new brochure describing complete line of PACE Transducers.

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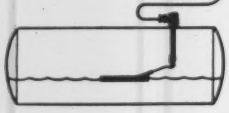
100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

Write for complete details, to Dept. E



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Prevent pressure damage with the IEC gage gard

GG-1 GG-2

Installed between a pressure source and a sensitive instrument, IEC's Gage Gard will

- **CUT OFF, preventing pressure increase at gauge or manometer whenever pressure exceeds the cut-off point. Models are available with cut-off ranges from 20" water to 9000 PSIG.***
- **HOLD CLOSED up to 10,000 PSIG, regardless of cut-off setting.**
- **REOPEN when pressure drops to 2% below cut-off point.**
- **REPEAT within 1% of scale.**

Cut-off pressure may be factory-set and sealed if you wish. You can adjust and reset at any time, however.

Both aluminum and stainless steel bodies are available in all models.

Write for Bulletin 546G for complete details and prices.

**For low-pressure protection — down to minus 15 PSIG — ask about the Gage Gard Jr. Bulletin 547G.*

INDUSTRIAL ENGINEERING CORPORATION
529 E. Woodbine, Louisville 8, Kentucky
Designers, engineers, and manufacturers of hydraulic and electronic test equipment, consoles, panels, etc.

For more information circle **160** on inquiry card.

PEOPLE—CONTINUED

S. B. Arnold

R. E. Owen

J. H. Rhodes

PACKARD BELL ELECTRONICS announces that *Lieutenant Commander Sam B. Arnold* (USN ret.) has joined the administrative staff as assistant to the director of sales and administration, Technical Products Div.

CONSOLIDATED ELECTRODYNAMICS CORP. has appointed *Robert R. Owen* marketing manager for electromechanical products.

PERKIN-ELMER CORP. announces appointment of *John H. Rhodes* as director of marketing of its Instrument Division.

SKINNER CHUCK CO. has appointed *William H. Mann* advertising manager for the Skinner Chuck and Electric Valve Divisions.

SORENSEN & CO. has named *P. J. Deery* manager of sales and quality control.

BRISTOL COMPANY announces appointment of *Otto J. Leone* as engineer for steel industry applications, with headquarters in Pittsburgh.

ALPHA WIRE CORP. announces promotion of *Don Rappaport* to assistant sales manager.

King MANOMETERS

For Plant and Laboratory

King Manometers are rugged, low-cost instruments of unexcelled accuracy for measuring pressure, vacuum, differential pressure, and pressure-related phenomena. They're available in the following types, in a complete range of sizes:

U-Type Manometers
- Single Cleanout
- With 3-Valve Manifold
- Double Cleanout
- Inverted U-Type

Well-Type Manometers
- Low-Well
- Barometric-Reading
- Raised-Well
- Flowmeter Type
- Inclined-Tube

Multi-Tube Manometers
- Individual-Well
- Common-Well
- Photo-Manometers

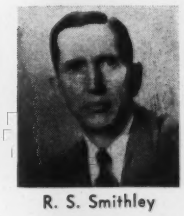
NEW CATALOG 2008 gives details on these and other models—includes manometer liquids and accessories—explains basic principles. Write—

KING ENGINEERING CORP.
Box 70 • Ann Arbor, Mich.
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **161** on inquiry card.

W. K. Dau

L. Van Blerkom



R. S. Smithley

KEARFOTT CO. announces appointment of *Walter K. Dau, Jr.* as sales manager.

FEDERAL PACIFIC ELECTRIC CO. announces that *Leopold Van Blerkom* has been appointed marketing manager of the Instrument Dept.. and *Richard S. Smithley* has been promoted to marketing manager-relays.

AMERICAN MACHINE AND METALS announces that *I. Newton Becker* has been elected to the company's board of directors.

VICTOREEN INSTRUMENT CO. announces appointment of *Irvin Zimet* as executive assistant to the president.

M-H, BROWN INSTRUMENTS DIV. announces appointment of *Robert D. Clarke* as market manager for the paper and textile industries.

DAYSTROM-WESTON DIVISIONS announce that *Joseph F. Degen* has been named vice president of operations for the Weston Instruments Division.

MANNING, MAXWELL & MOORE announces election of *Charles A. Moore* as chairman of the board and *Colby M. Chester 3rd* as treasurer.

ELECTRONIC ASSOCIATES, INC. has appointed *Jerome D. Kennedy* manager of its development engineering sales group.

OPTICS

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GALLIUM ANTIMONIDE
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INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
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LITHIUM FERRITE
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ALL TYPES KNOWN GLASS

* Carried in stock
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For more information circle **162** on inquiry card.

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LEPEL Electronic Tube GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.

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For more information circle **163** on inquiry card.

When the design calls for an indicating gauge, specify the best—
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For more information circle **164** on inquiry card.

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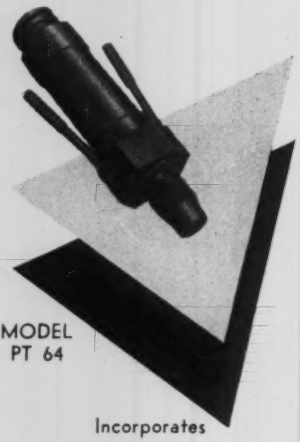
High Temperature Water-Cooled

PRESSURE TRANSDUCER



MODEL PT 64

Incorporates Unbonded Strain Gauge

HIGHLIGHTS

► DIAPHRAGM TEMPERATURES IN EXCESS OF 6000°F

► FLUSH-MOUNTED PRESSURE DIAPHRAGM

► MOUNTS IN 7/16-20 THREADED HOLE

► 1% ACCURACY

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write:

DYNAMIC INSTRUMENT CO.
APPLICATIONS ENGINEERING DEPT.
42 Carleton Street
Cambridge 42, Mass.
UN 4-7260

For more information circle **165** on inquiry card.

new literature

CONTROL SYSTEMS

DIGITAL SYSTEMS. 4-page Bulletin 100-D pictures and specifies digital system, composed of separate units, including voltmeter, a-c converter, ohmmeter, controller, ratiometer, etc. —Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.
For more information circle **278** on inquiry card.

CUSTOM CONTROL SYSTEMS. 8-page Bulletin 203 illustrates and describes custom-built systems for process, motor, machine, and power plant control.—Electro-Mech Corp., 55 Oak St., Norwood, N. J.
For more information circle **279** on inquiry card.

MACHINE TAPE-CONTROL. 14-page Bulletin 176 describes programming of machining operations by tape control.—Potter & Johnston Co., West Hartford, Conn.
For more information circle **280** on inquiry card.

MOTORS, SYNCHROS

SELSYNS AND SYNCHROS. 16-page Bulletin GEA-6675 discusses line of Selsyn and Synchro electromagnetic devices used for extremely accurate transmission of electrical angular data between two or more points.—General Electric Co., Schenectady 5, N. Y.
For more information circle **281** on inquiry card.

SERVO MOTOR. 4-page Bulletin MO-3.13 gives information on a 2-phase instrument servo motor.—Holtzer Cabot Motor Div., National Pneumatic Co., Inc. 125 Amory St., Boston, Mass.
For more information circle **282** on inquiry card.

VALVES

ENGINE STOP VALVES. 8-page Bulletin S-3A contains description, applications, sketches, and tables of automatic engine stop valve.—Golden Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.
For more information circle **283** on inquiry card.

BUTTERFLY VALVES. 4-page Bulletin 74 describes lever-operated, threaded-end butterfly valves.—Continental Equipment Co., Div. of Fisher Governor Co., Coraopolis, Penna.
For more information circle **284** on inquiry card.

SAUNDERS-TYPE CONTROL VALVES. 4-page Bulletin 114R contains information and dimensions of Saunders-patent springless valves for water treating, high vacuum, chemicals, and slurries.—Uniflow Valve Corp., Cranford, N. J.
For more information circle **285** on inquiry card.

BAR-STOCK CONTROL VALVES. 4-page Bulletin 116 details specifications of small-flow barstock valves for high-pressure applications, made of steel, stainless steel, brass, or aluminum.—Uniflow Valve Corp., Cranford, N. J.
For more information circle **286** on inquiry card.

TEMPERATURE

TEMPERATURE CONTROLLER. 4-page Bulletin GE-6001 describes electronic temperature controller for heat treating furnaces and other application. —Hagan Chemicals & Controls, Inc., Route 60 at Campbell Run Rd., P. O. Box 1346, Pittsburgh 30, Pa.
For more information circle **287** on inquiry card.

TEMPERATURE CONTROLLER. 8-page Brochure MC-177 describes Thermoswitch non-indicating controls and mounting wells.—Fenwal Incorporated, Leland St., Ashland, Mass.
For more information circle **288** on inquiry card.

THERMOCOUPLE GLAND. 4-page Bulletin MTG illustrates and describes the midget thermocouple gland which provides a positive seal for pressures from 0.005 microns to 5,000 psi, at a temperature range from −300°F to +1850°F.—Conax Corp., 2330 Walden Ave., Buffalo 25, N. Y.
For more information circle **289** on inquiry card.

FLOW, LEVEL

LEVEL CONTROLLER. 4-page Technical Bulletin RF-5910 explains operation of the Level-Tek level detection and control system for liquids, granular solids, or solids of a bulky and massive nature.—Robertshaw-Fulton Controls Co., Aeronautical and Instrument Div., 401 North Manchester Blvd., Anaheim, Calif.
For more information circle **290** on inquiry card.

TURBINE FLOWMETER. 3-page leaflet describes and illustrates turbine-type flowmeter for gases.—Pottermeter Co., Div. of Potter Aeronautical Corp., U.S. Route #22, Union, N. J.
For more information circle **291** on inquiry card.

AIRFLOW PROBES. 8-page Catalog 58 contains sketches and descriptions of traversing units; directional, temperature, pitot-static, and Kiel probes. —United Sensor & Control Corp., Box 127, Glastonbury, Conn.
For more information circle **292** on inquiry card.

INDICATORS AND CONTROLLERS. 4-page Bulletin A illustrates and describes complete line of liquid level, and specific gravity indicators, and controls.—Petrometer Corp., 43-22 Tenth St., Long Island City 1, N. Y.
For more information circle **293** on inquiry card.

FLOW RECORDER/CONTROLLERS. Series of five 2-page Spec. Sheets (51-1102G-1 to 5) describes line of electronic circular chart flow rate recorders and controllers.—Fischer & Porter Co., 846 Jacksonville Rd., Hatboro, Penna.
For more information circle **294** on inquiry card.

PRESSURE, VACUUM

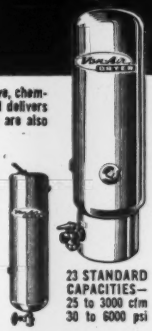
VACUUM TECHNOLOGY. 4-page issue of "Welch Duo-Seal Digest," Vol. 1/No. 6 contains 7 abstracts of articles on vacuum technology.—W. M. Welch Scientific Co., 1515 Sedgwick St., Chicago 10, Ill.
For more information circle **295** on inquiry card.

Shown above is 3000-cfm VAN-AIR Dryer—the type used by steel, automotive, chemical, container and other plants. Installed in compressor room it purifies and delivers clean, dry air to plant-wide operations. Many other capacities (see below) are also available in the complete line of VAN-AIR

COMPRESSED AIR DRYERS

THAT OPERATE FOR LESS THAN 1-CENT PER 16000 CU.FT.

The VAN-AIR Dryer is automatic. It purifies raw compressed air through a triple-action desiccator that extracts water and dirt—then reduces moisture to zero-dewpoint. It entails no heat, regeneration, volume loss or carry-over—under 1% pressure drop. The clean, dry, "instrument" quality of Van-treated air is indispensable for air controls, tools, processes, etc. as a guard against corrosion, pollution, dilution, freezing, etc.



23 STANDARD CAPACITIES—
25 to 3000 cfm
30 to 6000 psi

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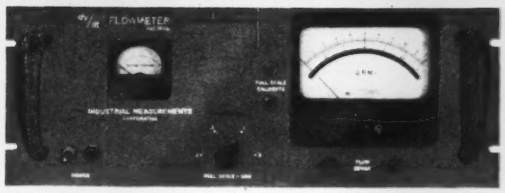
For more information circle **166** on inquiry card.

POSITIVE DISPLACEMENT FLOWMETER



New dV/dt FLOWMETER measures hydraulic flow over a range of 3000 to 1 on four scales. Standard models cover range from .001 to 48 GPM.

FEATURES:

- Insensitive to fluid viscosity and temperature
- Guaranteed accuracy
- Operates up to 5000 psig level
- Measures bi-directional flow

The standard models have wide application—including use as a flow calibration standard.

Variations available for nearly every flow measurement problem.

Send for additional information.

Industrial Measurements Corporation

IME Pomona California

SALES & SERVICE:

Industrial Measurements Sales, Inc.

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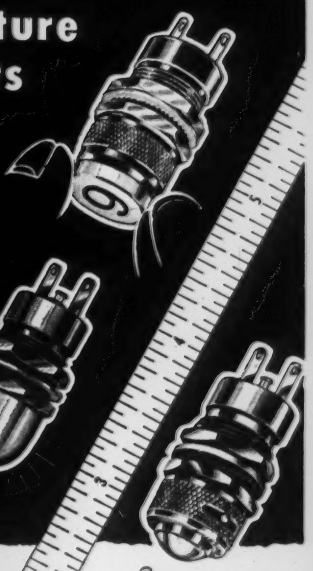
For more information circle **167** on inquiry card.

PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal Sub-Miniature Pilot Lights

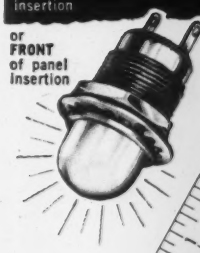
COMPACT
RUGGED
OMNIDIRECTIONAL
PLASTIC DOMES
COMPLETELY INSULATED

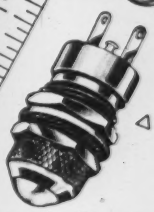


Also available with "Taper-Tab" quick-connect terminals

BACK of panel insertion

or FRONT of panel insertion





△ Dimming and ◁ Non-dimming types

Also

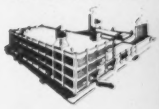
1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding* screw or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE



Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

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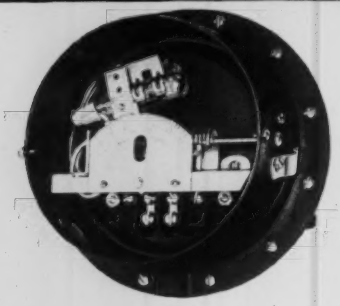
DIALIGHT CORP., 42 Stewart Ave., Brooklyn 37, N. Y.
☐ Send brochures on Sub-miniatures ☐ Selection Brochure ☐ Pilot Light Catalogues

Name ..... Position .....
Company .....
Address .....

For more information circle **168** on inquiry card.

new instrument



FM APPROVED

LOW PRESSURE DIAPHRAGM CONTROL

For Air or Gases

This FM approved (Mercoid Type PG) control can be used three different ways; for positive pressure; negative pressure (vacuum); for differential pressure or vacuum.

OPERATING RANGE 1.0" to 30.0" (H_2O)

FIXED DIFFERENTIAL (Sensitivity)
When operating point is set at

Low	Med.	High
0.6"	0.8"	1.0"

MAXIMUM PRESSURE 20 psig

Equipped with Fairprene diaphragm, external adjustments, hermetically sealed mercury switch—case made of heavy gauge steel (NEMA 1)

Available fully automatic or semi-automatic with manual reset.

Write for Bulletin PG to The Mercoid Corporation, 4231 Belmont Ave., Chicago 41.

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HIGH TEMPERATURE LIMIT CONTROL

Mercoid Type MX-51R for use with dryers, ovens, furnaces, etc. This adjustable indicating type high temperature limit control is actuated by a coiled bimetal element to result in a normally closed mercury (tube type) switch opening in event the supervised temperature reaches the preset limit point. A manual reset knob is arranged to reset mercury switch after high temperature operation and normal temperature restoration.

Operating Range (adjustable) 50-650° F. Minimum Differential 20° F. Electrical Rating 10A. 115V. 5A. 230V.

Has independent adjustments for setting both high and low operating points; visible calibrated dial; sealed mercury contact, reversible mounting flange. Case made of heavy gauge steel (NEMA 1)

Write for Bulletin SEB-51 to The Mercoid Corporation, 4231 Belmont Avenue, Chicago 41, Illinois.

SPECIFY
MERCOID® CONTROLS

For more information on PG circle **169** on inquiry card.

For more information on SEB circle **170** on inquiry card.

NEW LITERATURE

PRESSURE AND VACUUM GAGES. 32-page Catalog No. 525B describes indicating gages in 3½", 4", 6", and 8½" dial sizes in ranges from 10" W.C. to 10,000 psi. Recording gages in 8", 10" and 12" sizes are also illustrated.—Weksler Instrument Corp., 195 East Merrick Rd., Freeport, L. I., N. Y.

For more information circle **296** on inquiry card.

PRESSURE TRANSDUCERS. 4-page Bulletin 108 contains description, dimensional outline, and specifications of d-c pressure transducers P2-1200 through P2-1400 series.—Wiancko Engineering Co., 255 North Halstead Ave., Pasadena, Calif.

For more information circle **297** on inquiry card.

ATMOSPHERE CHART. Wallet-size ARDC Model atmosphere chart shows altitude in 1,000 ft increments to 1,800,000 feet with corresponding temperature (°F), pressure in mm, in. Hg and psia. Includes also vacuum equivalents, conversion of mm Hg and other factors.—Conrad, Inc., 141 Jefferson St., Holland, Mich.

For more information circle **298** on inquiry card.

COUNT

SINGLE-DECADE COUNTING UNITS 4-page bulletin illustrates and describes use of Sodeco counters in the solution of a wide variety of counting, telemetry and automation problems.—Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.

For more information circle **299** on inquiry card.

ELECTRONIC COUNTERS. 16-page technical data catalog describes and illustrates Models 14-20A and 14-20AT electronic counters.—Northeastern Engineering, Inc., 25 South Bedford St., Manchester, N. H.

For more information circle **300** on inquiry card.

WATER, AIR, STEAM

CHLORINATORS. 8-page issue of "Topics," Vol. 13/No. 1 contains a description of Aruba's (N. I.) seawater distillation plant using W & T chlorinators.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

For more information circle **301** on inquiry card.

AIR FILTERS. 2-page Bulletin No. 1505-7 describes new air line ultra filter for use with compressed air and other gas lines.—Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.

For more information circle **302** on inquiry card.

COMBUSTION CONTROL. 4-page Bulletin 515 gives information on chain-grate and spreader-type stokers, along with a discussion of steam pressure and steam-flow/air-flow measurement.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio

For more information circle **303** on inquiry card.

CHLORINIZERS. 4-page Sup. Bulletin 840.20A-2 explains in detail how automatic proportional chlorinizers operate in conjunction with Builders-Providence primary flow devices.—B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.

For more information circle **304** on inquiry card.

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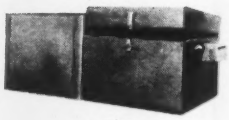
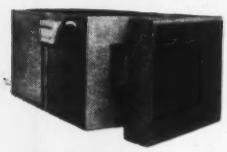
TEMP LINE SERIES





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SPECIAL QUANTITY PRICE

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FEATURING

MECHANICAL REFRIGERATION

—100°F to +250°F

- Ultra low temperature
- High temperature
- Stainless steel interiors
- Self contained
- Functional design
- Double door gasket
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For more information circle **171** on inquiry card.

NUCLEONICS

NUCLEAR INSTRUMENTS. 80-page General Catalog R contains pictures and specifications of scalers, gamma-ray spectrometers, count-rate meters, detectors, equipment for sample preparation and counting, etc.—Nuclear-Chicago Corp., 223 West Erie St., Chicago 10, Ill.

For more information circle **305** on inquiry card.

RADIOISOTOPES. 28-page Catalog B-9 covers nuclear accessories and related instrumentation.—Atomic Accessories, Inc., 244-02 Jamaica Ave., Bellerose 26, N. Y.

For more information circle **306** on inquiry card.

DATA HANDLING

ANALOG COMPUTER. 2-page Bulletin PIR855 describes the 60-amplifier 221R analog computer.—Electronic Associates, Inc., Long Branch Ave., Long Branch, N. J.

For more information circle **307** on inquiry card.

DIGITAL RECORDING SYSTEMS. 4-page Bulletin 311 describes building-block elements of digital data systems.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

For more information circle **308** on inquiry card.

DATA REDUCTION SYSTEMS. 8-page brochure describes RATE, the new series of automatic telemetry-data reduction systems.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

For more information circle **309** on inquiry card.

A/D CONVERTER. 4-page Bulletin BH100 describes Milli-V-Meter, a miniature analog-to-digital converter with digital readout.—B & H Instrument Co., Inc., 3479 West Vickery Blvd., Fort Worth 7, Texas.

For more information circle **310** on inquiry card.

COMPUTER REPORT. 4-page bulletin (Report No. 8) describes use of the G-15 general purpose digital computer in the petroleum industry.—Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

For more information circle **311** on inquiry card.

MAGNETIC TAPE. 16-page issue of "Readout," Vol. 1/No. 3, features an article "Tape Helps Tame the Thunder," dealing with noise research on Turbojets.—Ampex Instrumentation Div., 934 Charter St., Redwood City, Calif.

For more information circle **312** on inquiry card.

AUTOMATIC KEYSORT SYSTEM. 10-page Brochure S-500 describes in non-technical terms new automatic keysort system.—Royal McBee, Data Processing Div., Westchester Ave., Port Chester, N. Y.

For more information circle **313** on inquiry card.

TELEMETRY RECEIVING SYSTEM. 10-page Bulletin RTS-A-MRS illustrates typical miniature FM telemetry receiving systems, and describes individual building-block components.—Tele-Dynamics Inc., 5000 Parkside Ave., Phila. 31, Pa.

For more information circle **314** on inquiry card.

LANGUAGE TRANSLATOR. 6-page Brochure "Computer Language Translator for Data Processing Systems," describes off-line processing of data to permit full utilization of

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THE FIRST

COMPLETELY VERSATILE, PORTABLE

2-CHANNEL RECORDING SYSTEM

MASSA METERITE
Model BSA 200
Basic System Assembly with 2 PR-100 Preamplifiers

SALIENT FEATURES

- INTERCHANGEABLE PLUG-IN PREAMPLIFIERS—Low, Medium, High Gain DC; AC; Chopper; Carrier and Servo
- EXTENDED FREQUENCY RANGE—Full Scale Amplitude to 100 cps Reduced Amplitudes to 200 cps available
- RECTILINEAR MOTION—Free of Curvilinear Distortion
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- TRANSISTORIZED DRIVER AMPLIFIERS—Differential and Single Ended
- LIGHTWEIGHT—Approximately 35 lbs.

Also Available,
Multi-channel Modular Recording Systems.
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HINGHAM, MASSACHUSETTS

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specialized keyboards

Any number of keys in any arrangement you require – wired to your specifications – in a rugged steel case.

Concord Keyboards are particularly designed for reliable operation and specialized layout. Each key operates two normally open and two normally closed contacts simultaneously for maximum circuit flexibility. Key activated switches are rated for over 20 million cycles. Key action is positive, no adjustment or lubrication is necessary.

Typical example – $195.00 for a fourteen key keyboard wired to 4 foot cable and a Cannon connector. Case painted green. Delivery 3 weeks.

Send us a sketch of your desired key layout and wiring specifications. We'll send you an estimate by return mail.

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Flow Visualization Instrumentation

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Catalog upon request

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UHF COAXIAL WAVEMETERS

2-75 Centimeter Range

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86 Trowbridge St., Cambridge 38, Mass.
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computers and data processing systems.—Electronic Engineering Co., 1601 East Chestnut St., Santa Ana, Calif.
For more information circle **315** on inquiry card.

COMPUTER APPLICATION. 4-page Bulletin U1566 describes how the New York City Transit Authority is using a Univac 120 punched-card electronic computer.—Remington Rand Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.
For more information circle **316** on inquiry card.

NOR AND STROKE GATES. 11-page Technical Paper describes the use of SHEFFER STROKE and NOR gates in computer design.—Abacus, Inc., Department IP, 3040 Overland Ave., Los Angeles 34, Calif.
For more information circle **317** on inquiry card.

RECORDERS

RESISTANCE-RATIO RECORDERS. 2-page Data Sheet ND46-20(2) describes adaptation of Speedomax H recorder for measurements of pressure, flow, etc. detected by 3-terminal potentiometer-type transducers.—Leeds & Northrup Co., 4939 Stenton Ave., Phila. 44, Pa.
For more information circle **318** on inquiry card.

LABORATORY RECORDER. 18-page Bulletin R describes operation and applications of new potentiometer recorder.—E. H. Sargent & Co., Dept. BSR, 4647 West Foster Ave., Chicago 30, Ill.
For more information circle **319** on inquiry card.

TAPE RECORDER. 8-page Bulletin 55 describes the PS-200 magnetic tape instrumentation recorder.—Precision Instrument, Co., 1011 Commercial St., San Carlos, Calif.
For more information circle **320** on inquiry card.

TAPE DICTATING. 12-page Brochure "How to Measure Time With Tape," describes the superiorities of magnetic-tape dictation over the older disc-and-belt stylus methods.—DeJur-Amsco Corp., Business Equipment Div., 45-01 Northern Blvd., Long Island City 1, N. Y.
For more information circle **321** on inquiry card.

TESTING

TENSILE TESTER. 2-page Bulletin 750e describes production and laboratory tensile tester for electrical terminals.—Hunter Spring Co., a Div. of American Machine & Metals, Inc., 1 Spring Ave., Lansdale, Penna.
For more information circle **322** on inquiry card.

THERMISTOR ANALYZER. 2-page preliminary bulletin describes and specifies Model 702 thermistor analyzer.—Mid-eastern Electronics, Inc., 32 Commerce St., Springfield, N. J.
For more information circle **323** on inquiry card.

TILTING ROTARY TABLE. 2-page leaflet describes 24" table modified for sidereal rate of rotation.—Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.
For more information circle **324** on inquiry card

TESTING APPARATUS. 8-page bulletin describes line of testing apparatus for concrete, soils, asphalt, etc.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
For more information circle **325** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

DIGITAL INSTRUMENTS. 4-page Catalog No. 19-36 describes complete line of digital voltmeters, ratiometers, ohmmeters, preamplifiers, etc.—KIN TEL Div., Cohu Electronics, Inc., 5725 Kearny Villa Rd., Box 623, San Diego 12, Calif.

For more information circle **326** on inquiry card.

UNIVERSAL IMPEDANCE BRIDGE. 12-page issue of the "Experimenter," Vol. 33/No. 3 features a description of the universal impedance bridge.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For more information circle **327** on inquiry card.

VARIABLE TRANSFORMERS. 2-page Bulletin 151C describes line of variable transformers.—Ohmite Mfg. Co., 3681 Howard St., Skokie, Ill.

For more information circle **328** on inquiry card.

ELECTRONIC CONTROL METER. 4-page Data Sheet Form 308 provides full electrical and other specifications on Model 2545 control meter, which differs from conventional meters of this type by operating without the use of contacts at the set points.—International Instruments Inc., of New Haven, Conn.

For more information circle **329** on inquiry card.

PHASE METER. 2-page leaflet describes and specifies Phazor Model 200AB.—Industrial Test Equipment Co., 55 East 11th St., New York 3, N. Y.

For more information circle **330** on inquiry card.

AF AMPLIFIERS. 12-page Catalog 16-CA gives information on pre-amplifiers for laboratory, line, and magnetic recording; equalizers for magnetic-film playback; and oscillators.—Cinema Engineering Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

For more information circle **331** on inquiry card.

POTENTIOMETERS

POTENTIOMETERS, TRANSDUCERS. 8-page Instrument Summary Brochure gives info mation on line of linear-motion potentiometers, pressure transducers, accelerometers, and angular position transducers.—Bourns Laboratories, Inc., P. O. Box 2112, Riverside, Calif.

For more information circle **332** on inquiry card.

SINGLE-TURN POT. 4-page Data Sheet 1543 details single-turn Series 5400 precision potentiometer.—Beckman/Helipot Div., 2500 Fullerton Rd., Fullerton, Calif.

For more information circle **333** on inquiry card.

POWER SUPPLIES

POWER SUPPLIES. 12-page Catalog E59A gives information on d-c power supplies, a-c line voltage regulators, airborne radar power supplies, and static inverters and converters.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information circle **334** on inquiry card.

KLYSTRON POWER SUPPLY. 2-page bulletin describes Type 812 universal klystron power supply with digital readout for beam and reflector volt-

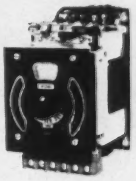
NEW DEVELOPMENTS IN

atc® **TIMING CONTROL**

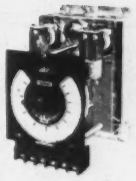
MISSILE TIMERS

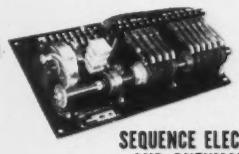
ATCOTROL MINIATURE RESET TIMERS

VERNIER SET AND CYCLE PROGRESS TIMERS

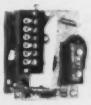


ELECTRONIC TIMERS





SEQUENCE ELECTRIC AND PNEUMATIC CAM TIMERS



DELAY TIMERS

WORLD'S LARGEST PROCESS TIME CONTROL

TWO COMPLETE REPEAT CYCLE TIMERS IN ONE MINIATURE CASE

Designed to control two separate circuits consecutively, the Atcotrol Duo-Set is a miniature masterpiece of simplicity, accuracy (¼% of scale) and dependability.

It embodies features usually obtained only in highest priced timers. For example, the motor reverses to change direction of the cycle progress pointer. This permits change in control point setting during the cycle and eliminates excessive mechanical parts. Load contacts are rated at 10 amps, 115 volts.

Duo-Set Timers incorporate all the service-proved features of the Atcotrol design . . . easily mounted, quickly removed for inspection while operating, self-cleaning contacts, fully protected one-piece compression molded terminal block and one-piece tubular rolled laminate slip-off cover.

TEN STANDARD DIAL RANGES

15, 30, 60, 120, 240 seconds
15, 30, 60, 120, 240 minutes

Write today for Bulletin No. N-80. Free demonstration on request.

AUTOMATIC TIMING & CONTROLS, Inc.

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ATC EXPORT DEPARTMENT, 1010 SCHAFF BUILDING, PHILADELPHIA 2, PA., U.S.A.

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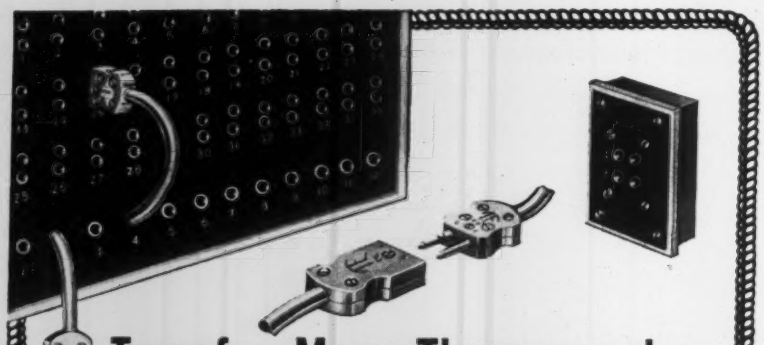

Transfer Many Thermocouples

With T-E Quick-Coupling Connectors and Panels

Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multi-point recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

Quick-Coupling Connectors These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

Write for Bulletin 23 F

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **177** on inquiry card.

HARDNESS TESTING

SCLEROSCOPE FOR TESTING THE HARDNESS OF METALS. PIONEER AMERICAN HARDNESS STANDARD. OVER 40,000 IN USE.

***DUROMETER* FOR TESTING THE HARDNESS OF RUBBER & RUBBER-LIKE MATERIALS (ASTM D676) (ASTM D1484)**

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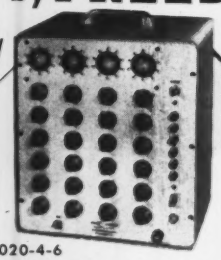
JAMAICA 35, N. Y.

For more information circle **178** on inquiry card.

NEW!! MULTIPLE PRESET COUNTER by FREED



TYPE 2020-4-6

The Freed Type 2020-4-6 Multiple Preset Counter was designed for sequential predetermining control and is ideally suited for applications when a machine or a process is started manually and stops automatically at several preset counts in one operation. One of the applications for this counter is the winding of tapped toroidal or transformer coils.

Premium components, simplified circuits, using a minimum of computer type vacuum tubes and a silicon diode power supply provides reliable maintenance free operation.

SPECIFICATIONS

- **MAXIMUM COUNT:** 4 digits 9,999
- **COUNTING RATE:** 4000 per second
- **PRESETS:** 1-6
- **INPUT:** Photocell, Switch closure, Pulse
- **OUTPUT:** Relay DPDT — 5 Amp contacts
- **SIZE:** 11 x 13 x 8⅝ inches
- **WEIGHT:** 19½ lbs.
- **POWER SUPPLY:** 105-125 Volts—50-60 cycles

Freed also manufactures Preset, Totalizing, Batching and Timing counters.

Send for complete information.

FREED TRANSFORMER CO., INC.
1707 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.

For more information circle **179** on inquiry card.

ages.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

For more information circle **335** on inquiry card.

POWER SUPPLIES. 16-page Catalog B591 describes line of voltage-and-current-regulated power supplies including transistorized, magnetic and vacuum tube types.—Kepco Labs., Inc., 131-38 Sanford Ave., Flushing 55, N. Y.

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ELECTRICAL, ELECTRONIC COMPONENTS

PRECISION COMPONENTS. 4-page Bulletin 216 contains dimensional sketches, physical data, and tuning-range-vs-load-capacitance graphs of LC tuners.—JFD Electronics Corp., 1462-62 St., Brooklyn, N. Y.

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PHOTOCELLS. 8-page issue of "Rectifier News," RN-359 contains a description of selenium contour photocells.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

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MINIATURE INDICATOR. 2-page Data Sheet describes lighting indicator unit No. 101N-022 with built-in 22,000-ohm resistor, for use with G.E. NE51H lamp.—Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill.

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COMMUTATORS. 12-page catalog tabulates multi-channel electromechanical commutation devices with specifications and applications.—General Devices Inc., P. O. Box 253, Princeton, N. J.

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RELAYS, STEPPERS, ETC. 8-page illustrated folder features a wide assortment of relays, steppers, solenoids, contactors, rectifiers, and related components.—Universal Relay Corp., 42 White St., New York 13, N. Y.

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PULSE TRANSFORMERS. 2-page technical bulletin describes the P series miniature encapsulated pulse transformers, designed especially for printed circuit and automatic assembly applications.—Technitrol Engineering Co., 1952 E. Allegheny Ave., Phila. 34, Pa.

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SELENIUM RECTIFIERS. 8-page catalog on Rectico Selenium Rectifiers contains basic characteristics and general design information on rectifier circuits.—Rectico, Inc., 963 Frelinghuysen Ave., Newark 12, N. J.

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MINIATURE TOROIDAL INDUCTOR. 2-page Data Sheet I 8-1 gives details on Series 781 miniature toroidal inductors.—Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

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D-C/A-C CHOPPER. 2-page bulletin describes d-c/a-c SPDT choppers.—Rawco Instruments, Inc., 3527 West Rosedale, Fort Worth 7, Texas.

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RESOLVER. 2-page Product Data Sheet 117-8 describes and specifies Series 2010C triple resolver.—Lear/Grand Rapids Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.
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CABLE, CONNECTORS

INTER-WOVEN CABLE. Data Sheet C-1 describes and illustrates new low-pickup minimum-radiation Inter-8 Cable with realizable field reductions up to 20 db.—Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.
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SILICONE RUBBER DIELECTRICS. 8-page issue of "Amphenol Engineering News," Vol. 12/No. 1 features an article "Silicon Rubber as Connector Insert and Grommet Material."—Amphenol-Borg Electronics Corp., 1830 South 54th Ave., Chicago 50, Ill.
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MULTIPIN CONNECTORS. 4-page folder SEC 2100 gives information to buyers and engineers in the selection of Amphenol connectors.—Schweber Electronics, 60 Herricks Rd., Mineola, L. I., N. Y.
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MATERIALS

CERAMIC INSULATORS. 4-page Bulletin 1590A describes properties and applications of Ceramicite for high-temperature hermetic seals.—Consolidated Electrodynamics Corp., Transducer Div., 300 North Sierra Madre Villa, Pasadena, Calif.
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LUBE OILS. 2-page Data File Sheet F-15 lists instruments and machines and the recommended grade of Flozene oil for their lubrication.—L. Sonneborn Sons, Inc., 300 Fourth Ave., New York 10, N. Y.
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MISCELLANEOUS

JEWEL BEARINGS. 12-page issue of "Weston Engineering Notes," Vol. 13/No. 1 contains an article comparing glass jewels with sapphire jewels.—Weston Instruments, Div. of Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.
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STAMPING MACHINES. Catalog 54-HS describes and illustrates Acroleaf and Acromark presses and equipment for hot stamping plastic parts, products and materials.—Akromark Co., 3-11 Morrell St., Elizabeth 4, N. J.
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LIQUEFIED-GAS CONTAINERS. 6-page Folder F-1254 describes complete line of small containers for the transport and storage of liquefied gases.—Linde Co., Div. of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
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PULSE AMPLIFIER. 4-page Bulletin E-274A contains engineering data on duotriode pulse amplifier 6955.—CBS-Hytron, a Div. of Columbia Broadcasting System, Inc., Danvers, Mass.
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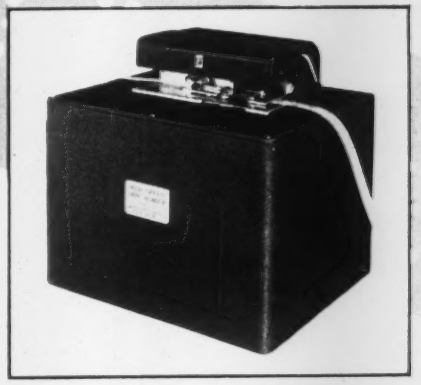

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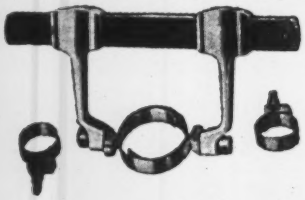

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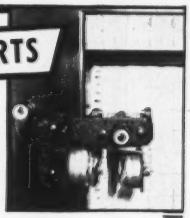

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MISSING AUTHOR

We have a manuscript on hand "Elongation Switches Monitor Stress" by Thomas E. Nicholas, last known address 3029 Adams Ave., San Diego 16, Calif. We are trying to contact Mr. Nicholas.

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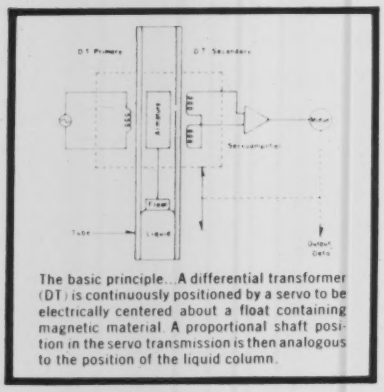

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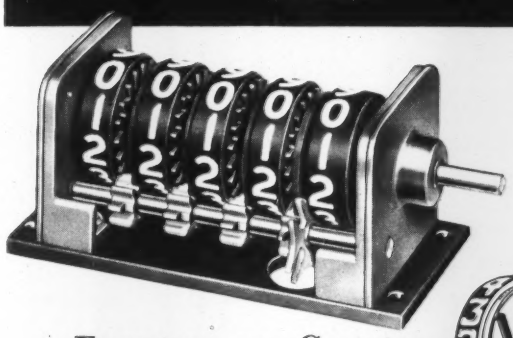

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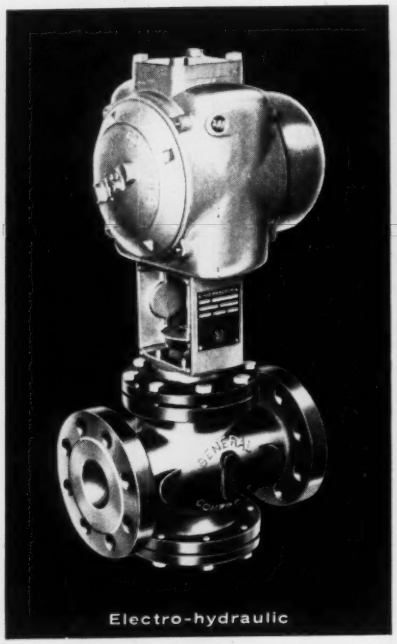

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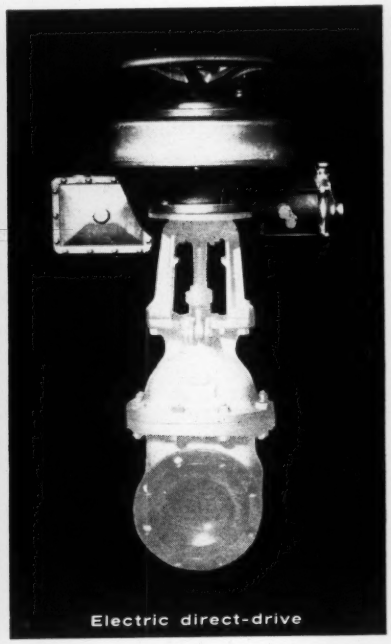

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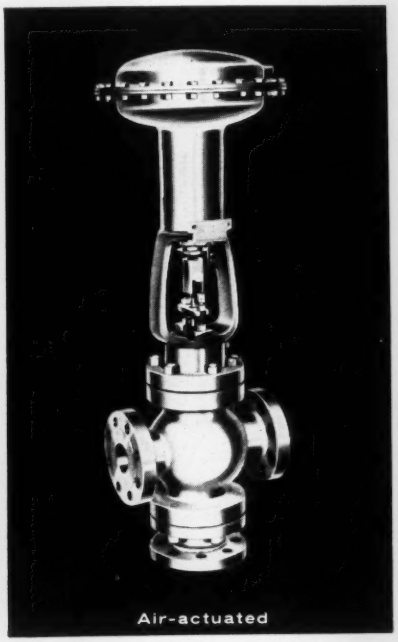

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